Conservation Assessment of *Xanthosia scopulicola* J.M.Hart & Henwood (Apiaceae)

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Xanthosia scopulicola J.M.Hart & Henwood (Apiaceae)

Distribution: Endemic to NSW
Current EPBC Act Status: Not listed
Current NSW BC Act Status: Vulnerable
Proposed listing on NSW BC Act: Delist

Reason for change: Non-genuine change based on increased knowledge about the distribution, abundance and ecology of the species.

Summary of Conservation Assessment

Xanthosia scopulicola J.M.Hart & Henwood was found to be ineligible for listing as a threatened species as none of the criteria were met.

Description and Taxonomy

Xanthosia scopulicola growing near Wentworth Falls, NSW. Image: Gavin Phillips

Xanthosia scopulicola (family Apiaceae) was described by Hart and Henwood (2000) as an “ascending perennial subshrub to 20 cm high. Taproot woody with a flaky or corky surface. Plants stellately tomentose on young stems and leaves; the mature stems excorticating. Leaves grey-green, cauline, juvenile leaves trifoliolate, adult

leaves simple. Petiole 2–15 mm long, angular, grooved above, sheathing shortly at the base, sheaths 1–2 mm long. Leaflets of the trifoliate leaves ovate, the terminal leaflet longer than the lateral leaflets, terminal leaflet 5–20 mm long, 5–25 mm wide, lateral leaflets 3–5 mm long, 3–4 mm wide, petiolulate or sessile. Simple leaves ovate, 5–20 mm long, 5–25 mm wide. Leaf margins flat to slightly recurved, crenate; apex obtuse. Inflorescence a compound umbel with 2 or 3 rays, 1–4 flowers per ray; flowers bisexual or rarely male. Rays terete, 2–4 mm long. Involucral bracts 2 or 3, triangular, foliaceous, green, longer or shorter than the rays, 2–3 mm long, *c.* 1 mm wide, apex acute. Bracteoles 3, elliptic to obovate, petaloid, yellow, shorter or longer than flowers, 3–5 mm long, 1–3 mm wide, apex acuminate or obtuse. Inflorescences pedunculate; peduncles 5–25 mm long. Flowers pedicellate; pedicels 1–2 mm long. Sepals ovate, 1–1.2 mm long, *c.* 0.7 mm wide, green or yellow, base truncate, apex obtuse, glabrous. Petals longer than sepals, 1.0–1.2 mm long, *c.* 0.5 mm wide, white, midrib adaxially keeled and bridged with the inflexed appendage, apex obtuse, appendage smooth. Nectaries raised and prominent, *c.* 0.9 mm high, white or yellow, hirsute. Styles 1.3–2.3 mm long. Ovary hirsute. Male flowers having an undeveloped inconspicuous ovary, with the styles barely protruding above the nectaries. Fruit brown, ovate, 2.0–2.2 mm long, 2.0–2.2 mm wide, *c*. 0.5 mm deep. Monocarps hirsute on the summit, elliptic in transverse section, 7–9-ribbed; ribs keeled."

Xanthosia scopulicola is differentiated from other, sometimes co-occurring, *Xanthosia* species by its form of compact and much-branched subshrub on which the older branches of the mature plants excorticate, resulting in a distinctive, flaky surface texture (Hart and Henwood 2000). The leaves are dull grey-green in colour, and on young plants the leaves are consistently trifoliolate, later becoming simple, with transitional leaves being deeply lobed. *Xanthosia scopulicola* is differentiated from *X. pilosa* by the excorticating bark (*c.f.* not excorticating), grey-green leaves *(c.f.* green leaves) and the stellate trichomes on the leaf adaxial surface (*c.f.* dendritic trichomes*).* *Xanthosia scopulicola* is then differentiated from *X. stellata*, which also has stellate-trichome leaves, as *X. stellata* always has leaves that are trifoliolate, with the leaflets petiolulate. In *X. stellata* the mature plants have leaflets that are consistently three-lobed and about equal in length, and on young plants the leaves may be larger with the terminal leaflet deeply lobed or split.

Distribution and Abundance

Xanthosia scopulicola is restricted to sandstone cliff faces or rocky outcrops of the upper Blue Mountains. It is found along approximately 25 km of escarpment in the Jamison and Kedumba Valleys between Kings Tableland in Wentworth Falls and the Megalong Cleft in Katoomba, and on the northern side of the Grose Valley. The species grows in crevices on sheer cliff faces or on rocky outcrops above the cliffs at many scattered locations along the main upper Blue Mountains escarpment and nearby broken cliff lines and large boulders, predominantly at elevations of 750–1000 m a.s.l. (Hart and Henwood 2000; ALA 2024). In 2019, the species was recorded for the first time from the northern escarpment of the Grose Valley, where it has now been found at three sites with a linear extent of 10 km. Most of the population is located within Blue Mountains National Park. *Xanthosia scopulicola* occurs on the traditional lands of the Dharug and Gundungarra people (AIATSIS 2022), who have a strong and ongoing cultural connection with their traditional lands and waters.

Based on the potential for gene exchange between individuals, there are considered to be two subpopulations (as defined by IUCN 2024) of *Xanthosia scopulicola*: one in the Grose Valley, and one in Jamieson/Kedumba Valleys.

The total population size of *Xanthosia scopulicola* is estimated to be a minimum of 2,000. The population estimate is based on an extrapolation of counts from surveys along walking tracks targeting known records (V. Wong pers. obs. October 2022).

In 2022, surveys counted individuals (mostly mature) within 10m of three walking tracks that bisect the cliff line: Golden Stairs on Narrow Neck in Katoomba (68), and the Nature Track (161) and Wentworth Falls track in Wentworth Falls (110). The minimum population size estimate of 2,000 has been derived by multiplying the average number of individuals recorded at each of the three 2022 survey sites (113) by the number of discrete sites where the species has been recorded across both subpopulations (19). This population estimate is considered extremely conservative because of the extensive area of potential habitat that exists in unsurveyed, inaccessible areas of the escarpment.

The 2022 survey of *Xanthosia scopulicola* covered approximately 3.5 km of walking tracks or, when measured in two dimensions on a map, approximately 1.2 km of cliff line. The linear extent of the species range measures 25 km between Kings Tableland and the Megalong Cleft, and an additional 10km of escarpment between records in the Grose Valley and has extensive areas of mostly inaccessible cliff line. In addition, these measurements do not include the many gullies, convolutions and duplications in the cliffs. This comprises an extensive area that is likely to include further areas of suitable habitat for *X. scopulicola*. Known occurrence records are from scattered sites, often with the comment “locally common” (National Herbarium of New South Wales collections database accessed 20 February 2024). *Xanthosia scopulicola* has been observed to be absent from cliff lines at Sublime Point and from certain sections of the Katoomba Cliffs (G. Phillips pers. obs. 2015). This suggests that *X. scopulicola* might have specific microhabitat requirements and a naturally scattered distribution but is common in patches of suitable habitat.

There is no long-term monitoring information available for *Xanthosia scopulicola* and there is no information on long-term population trends.

Area of occupancy and extent of occurrence

The extent of occurrence for *Xanthosia scopulicola* (EOO) is estimated at 183 km^2, and the area of occurrence (AOO) is estimated at 52 km^2. The Extent of Occurrence (EOO) is based on a minimum convex polygon enclosing all mapped occurrences of the species, the method of assessment recommended by IUCN (2024). The AOO is based on 2 x 2 km grid cells, the scale recommended for assessing area of occupancy by IUCN (2024). The EOO and AOO were calculated using Kew Geospatial Conservation Assessment Tool (GeoCAT; Bachman *et al.* 2011) and encompasses the entire known past and extant distribution of the species.

The distribution of *Xanthosia scopulicola* is based on 60 unique records compiled from the NSW BioNet Atlas, the Atlas of Living Australia (ALA) and herbarium specimen records, and 32 records from survey results (V. Wong pers. obs. October 2022). Sixteen database records were considered incorrectly located, and of these 11 were excluded and 5 relocated according to the site description.

Number of locations

There are two threat-defined locations as defined by IUCN (2024), based on the two subpopulations and the most serious plausible threat of adverse fire regimes. The two subpopulations are considered separate locations not just because of their geographic separation, but also because of their differing fire histories. Infrequent small patchy fires are typical of the Jamieson and Kedumba Valleys, whereas the Grose Valley has a history of large, widespread fires approximately every decade (NPWS 2024), and so the two subpopulations are unlikely to be affected by the same fire event, and the relative threats of high frequency and high intensity fires are likely to differ between the two subpopulations.

Ecology

Habitat

Xanthosia scopulicola grows in skeletal soils in cracks and crevices of sandstone cliff faces, on ledges, under overhangs or in clay bands in the rockface, or (less commonly) on rocky outcrops above the cliffs (ALA 2024; National Herbarium of New South Wales collections database accessed 20 February 2024). Known occurrences are predominantly on south-facing cliffs along the northern escarpments of the Grose and Jamieson Valleys in the Blue Mountains NP, at altitudes of (550–)750–1000 m elevation. Where aspect is included in occurrence records, south facing is the most commonly given, although aspect varies, presumably due to undulations in the cliff face. Mean annual rainfall at Katoomba (the nearest weather station, 1017 m a.s.l.) is 1410 mm (Bureau of Meteorology 2024). Associated species include *Alania cunninghamii*, *Amperea xiphoclada*, *Baeckea linifolia*, *Blandfordia cunninghamii*, *Dracophyllum secundum*, *Empodisma minus*, *Epacris rigida*, *Eucalyptus oreades* and *E. piperita*, *Gleichenia dicarpa, G. rupestris,* and *Sprengelia monticola* (ALA 2024; National Herbarium of New South Wales collections database accessed 20 February 2024).

Life history and population dynamics

Xanthosia scopulicola is a perennial subshrub with a deep taproot with a compact and much-branched habit (Hart and Henwood 2000; PlantNET 2024). *Xanthosia scopulicola* is known to flower between November to January (PlantNET 2024), but sporadic flowering may occur at any time of year (Hart and Henwood 2000). There is no information available on longevity or time to maturity. However, the slow development of the excoriating bark over at least several years (V. Wong pers. obs. July 2023) suggests that the subshrub can live for many years.

Xanthosia contains both resprouting and obligate seeding plants (Benson and McDougall 1993). *Xanthosia scopulicola* at Narrow Neck was observed to resprout after fire and to have very limited recruitment from seed post-fire, contrasting with the co-occurring *X. pilosa*, which was observed to have mass recruitment from seed after the same fire in late 2019 (V. Wong pers. obs. December 2021). Resprouting individuals have been observed to have flowers two years after fire but are likely to flower in the first year after fire (V Wong pers. obs. December 2021). Newly resprouted stems, and younger stems generally, do not display the diagnostic flaky bark (Hart and Henwood 2000; V Wong pers. obs. December 2021).

Xanthosia scopulicola, like many other species in the genus, has small inconspicuous light-yellow flowers. Western Australian species of *Xanthosia* studied fall into two groups based on pollination mechanisms, the first group with small inconspicuous flowers being largely self-pollinated and the second group with larger, showy inflorescences being pollinated by native bees, muscid (Muscidae) and beeflies (Bombyliidae) and hoverflies (Syrphidae) (Keighery 1982). Pollination mechanisms of eastern Australian *Xanthosia* are unknown but, as the flowers of *X. scopulicola* are inconspicuous it is inferred they are largely self-pollinated. The fruit dehisces into two single-seeded indehiscent mericarps, which are the unit of dispersal. The keeled ribs and the apical tuft of hairs on the mericarps are likely to be adaptations for dispersal, particularly by wind (Plunkett *et al.* 2018). The mericarps are likely also dispersed short distances by gravity and water flowing down cliff faces. Myrmecochory (ant dispersal) has also been recorded in the closely related *X. pilosa* and other species of *Xanthosia* (Rice and Westoby 1981). Seed dormancy and germination requirements are unknown.

Threats

On the initial listing, the NSW Scientific Committee (2003) documented a number of threats potentially affecting *Xanthosia scopulicola*. These include habitat disturbance from track maintenance, disturbance by walkers, urban runoff and weed encroachment. Most of these threats are associated with walking tracks and urban drain outflows within known habitat, which is strongly suspected to affect a very small proportion of the total extent of this species.

Other plausible threats to *Xanthosia scopulicola* include adverse fire regimes, and increased frequency and intensity of both drought and extreme rainfall events due to climate change.

Adverse fire regimes

Adverse fire regimes, including high frequency fire and high severity fire, are a plausible threat to *Xanthosia scopulicola* as a subshrub, although the species preferred habitat of open, vertical cliff faces, the ability to resprout, and protection of the taproot in crevices in the cliff face, may enable some individuals to survive and resprout after fire. More importantly, the fire history of the Jamieson and Kedumba Valleys is of small patchy fires with only two of the 16 known sites for *X. scopulicola* having any recorded history of wildfire (NPWS 2024). Larger wildfires are recorded in the Grose Valley (NPWS 2024), but the high, predominantly south facing cliffs that *X. scopulicola* inhabits, and surrounding mesic vegetation, are likely to provide some protection from even high severity fire.

The majority of the known habitat of *Xanthosia scopulicola* does not have a history of high frequency fire at any severity. In the Jamieson and Kedumba Valley subpopulation, Narrow Neck Plateau and near Kedumba Pass on the Kings Tableland are the only sites with known occurrences of *X. scopulicola* that have a record of bushfire in the last decade, with prescribed burns also only affecting a small area which are unlikely to have breached the cliff lines on which *X. scopulicola* occurs. ,The south facing cliffs of Katoomba and Wentworth Falls have a history of infrequent and small, patchy fires (NPWS 2024), with only small areas near to records of *X. scopulicola*

burnt at any one time. On the northern Grose Valley escarpment, the history is of larger, more frequent fires occurring approximately every decade. Here, there is more chance of repeated short-interval fires, however, the protection provided by south-facing cliffs is likely to limit the extent of fire recurrence within the species' habitat. Furthermore, as large-scale fire mapping does not capture burn heterogeneity, unburnt areas are likely to remain within the wider burnt area-polygon (Kolden *et al.* 2012; Leonard *et al.* 2014) and fire size is only weakly inversely correlated with unburnt area within the fire perimeter (Kaldon *et al.* 2012). This means that it is highly likely that most known sites of *X. scopulicola* have very seldom, if ever, burnt, and this is supported by field observations of the plants *in situ* where no historical fire affects are notable in the surrounding vegetation structure (G. Phillips pers. obs. December 2018, October 2022).

Cliffs and rocky outcrops may act as refugia from fire (Clarke 2002; Robinson *et al*. 2013; Selwood and Zimmer 2020). The presence of large tracts of bare rock, in combination with the vertical to overhanging aspects of many sites where *Xanthosia scopulicola* grows, mean that surface fuels required to propagate fire are virtually non-existent (G. Phillips pers. obs. October 2022), and this commonly results in cliffs acting as highly effective natural fire breaks (Price *et al.* 2007). Wood *et al.* (2011) found that south-facing slopes also burn less frequently than north facing slopes, and it is inferred that south-facing cliffs, the predominant microhabitat of *Xanthosia scopulicola*, are similarly protected from fire. South-facing cliffs are also known to provide cooler microhabitats (Speziale and Ezcurra 2014), and this can further buffer against the effects of fire and drought (Selwood and Zimmer 2020). In addition, surrounding vegetation type is a determinant of unburnt area, with unburnt area increasing as vegetation becomes more mesic (Wood *et al.* 2011; Leonard *et al.* 2014). The majority of species associated with *X. scopulicola* are noted to occur on wet cliff faces or other wet places and include ferns, rushes and other mesic species (PlantNET 2024). Fire is likely to be an extremely rare event on the cliff faces that the species occupies. The effects of high frequency fire on *Xanthosia scopulicola* remain unlikely even with consideration of predicted increases in wildfire frequency and size in south-eastern Australian under a changing climate (Abatzoglou *et al.* 2019; Bowman *et al*. 2020; Gallagher *et al*. 2021).

The moist cliff face and rocky outcrop habitat of *Xanthosia scopulicola* would be most likely to be breached by high severity fire. The proportion of unburnt area within the fire perimeter is known to decrease with fire severity (Kaldon *et al.* 2012; Leonard *et al.* 2014), and this was the case at Narrow Neck and Kings Tableland in the 2019–2020 fires. However, plants at Narrow Neck were observed to successfully resprout where they were affected by high severity fire, although proportional survival is not known (V. Wong pers. obs. December 2021). Information about whether plants in the Grose Valley subpopulation were burnt in 2019–2020 or not is largely lacking, but plants in the Dalpura canyon area of the Grose Valley were observed to be flowering only two years post-fire (V. Wong pers. obs. December 2021). It is therefore inferred that the populations of *X. scopulicola* are unlikely to be exposed to high severity fire, in part because only some sites are likely to burn in a single fire, and also because of the observed resprouting after high severity fire. This means that high severity fire is not currently considered to be causing continuing decline in either the habitat, the distribution, or the abundance of *X. scopulicola*, and there is no certainty that such declines will become apparent in the future. 'High frequency fire resulting in the

disruption of life cycle processes in plants and animals and loss of vegetation structure and composition' is a key threatening process under the NSW Biodiversity Conservation Act 2016. 'Fire regimes that cause declines in biodiversity' is a key threatening process under the Environment Protection and Biodiversity Conservation (EPBC) Act 1999.

Extreme weather events (drought and heavy rainfall) from climate change

Extreme weather events from climate change, including higher intensity and frequency of drought and heavy rainfall events (Bureau of Meteorology 2022; IPCC 2023), can affect range restricted species like *Xanthosia scopulicola* (*e.g*., Harris *et al.* 2018; Hoffman *et al.* 2018). The response of *X. scopulicola* to drought and to excess rainfall is incompletely known. Some individuals at Wentworth Falls were observed to die back during both the 2017–2019 drought and during subsequent very wet periods associated with a La Nina event in 2020–2022, however they later resprouted when rainfall returned to more usual levels (V. Wong pers. obs. 2017–2022). This ability to resprout would be expected to protect *X. scopulicola* from continuing decline in population size due to unfavourable climatic events. From recent field surveys and other available data, decline in population size due to these mechanisms was not observed.

Although the skeletal soils in which *X. scopulicola* grows would be expected to dry quickly between rainfall events, the long tap root may be able access moisture retained in rock crevices or deeper in clay bands. The dense tomentose stellate indumentum of *X. scopulicola* would also provide protection from desiccation during relatively dry times. The majority of occurrences are on more or less south-facing cliff faces, which would retain moisture for longer than sites with other aspects. These areas are known to provide refugia from high temperatures and may support mesic plant communities during arid periods (Speziale and Ezcurra 2014; Selwood and Zimmer 2020).

Xanthosia scopulicola is adapted to a high rainfall habitat, and its habit of growing on vertical cliff faces means that the species would not be subject to inundation.

Disturbance from track maintenance and by walkers

Disturbance from track maintenance and by walkers was cited as a threat by NSW Scientific Committee (2003). Walking tracks represent a small proportion of the known habitat of *Xanthosia scopulicola*. The majority of suitable habitat that occurs in the known range of the species is inaccessible cliff faces up to 300 m high within national park that are not affected by these threats. Where *X. scopulicola* is known to occur along walking tracks, most commonly steep, fenced staircases intersect the cliff face habitat of the species (e.g., The Golden Stairs Walking Track), or the species is found on vertical surfaces beside the track (e.g., Undercliff Walking Track), meaning off-track trampling is highly unlikely. *Xanthosia scopulicola* is therefore considered to not be subject to trampling by walkers, disturbance along walking tracks is likely to be minimal, and tracks represent a very small proportion of the total extent of this species. From field surveys carried out for this assessment and other available data, continuing decline is not observed in either the number of plants or habitat quality of *X. scopulicola* at sites accessible by walking trails, and this threat is not expected to increase into the future.

Urban runoff and weed encroachment

Urban runoff was cited as a threat by NSW Scientific Committee (2003). Urban stormwater runoff contains elevated levels of sediment and nutrients and might contain other pollutants including heavy metals (Draper *et al.* 2022). Concentrations of sediment, nutrients and other pollutants in stormwater runoff found in recent studies are significantly lower than those found two decades ago, presumably due to advancements in pollution control and stormwater management and are typically lower in runoff from residential areas than in runoff from agricultural or industrial areas (Müller *et al.* 2020; Draper *et al.* 2022). The Grose Valley subpopulation of *Xanthosia scopulicola*, which is surrounded by National Park, would not be exposed to urban runoff, and only those parts of the Jamieson Valley subpopulation that are near housing and other development would potentially be exposed. Even then, urban runoff would be restricted to waterfalls or other stormwater channels and not distributed across all sites inhabited by *X. scopulicola*. The adverse effects of runoff are greatest to waterways and are likely to be limited for the preferred cliff face habitat of *X. scopulicola*, where pooling of runoff would not occur.

Urban runoff can also contribute to weed encroachment by spreading weed seeds or other propagules and promoting their establishment due to nutrient runoff or erosion (Blue Mountains City Council 2019). Garden escapes, dumping of waste and transport of seeds by wind, birds and vehicles and on clothing and boots of bushwalkers are also major causes of weed spread (Blue Mountains City Council 2019). Weed encroachment was listed as a threat to *Xanthosia scopulicola* by NSW Scientific Committee (2003). However, the cliff face habitat of *X. scopulicola* likely limits establishment of many weed species, and the inaccessibility of most sites where the species is known or likely to occur limits anthropogenic spread of weeds. Cliff faces and rock underhangs where *X. scopulicola* is known to occur are typically sparsely vegetated (K. Gibbons pers. obs. 2009, 2012), limiting competition from any weeds that manage to establish. Blue mountains City Council has an active and detailed weed management strategy to mitigate the effects of weeds on biodiversity within the Local Government Area (Blue Mountains City Council 2019).

From field observations and other available data, there is no evidence to suggest that urban runoff or weed encroachment is posing a threat to *Xanthosia scopulicola* sufficient to cause continuing decline in population size or area, extent and/or quality of habitat.

Assessment against IUCN Red List criteria

For this assessment it is considered that the survey of *Xanthosia scopulicola*, while limited due to issues with access to the majority of suitable habitat, has been adequate and there is sufficient scientific evidence to support the listing outcome.

Criterion A *Population Size reduction*

Assessment Outcome: Data Deficient.

Justification: There is no information available on population trends for *Xanthosia scopulicola*.

Criterion B Geographic range

Assessment Outcome: Not met.

Justification: The extent of occurrence (EOO) is 183 km^2 (based on a convex hull polygon fitted around all known records as per IUCN Guidelines (2022), which meets the threshold for Endangered (<5000 km^2). The area of occurrence (AOO) is 52 km^2, estimated using a 2 x 2 km grid, as per IUCN Guidelines (2022), meeting the threshold for Endangered (<500 km^2). However, criterion B is not met because there is no observed, estimated, inferred or projected continuing decline 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.

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 there is 1 (CR), ≤5 (EN) or ≤10 (VU) locations.

Assessment Outcome: Met for Endangered as there are two threat-based locations.

Justification: All known individuals of *Xanthosia scopulicola* occur within two expanses of habitat, along the (predominantly northern) escarpments of the Jamison and Kedumba Valleys and along the northern escarpment of the Grose Valley. These two areas constitute two threat-defined locations, based on the most serious plausible threat of adverse fire regimes. The Jamieson/Kedumba Valleys and the Grose Valley are not only geographically separated, their differing fire histories also mean they are unlikely to be affected by the same fire event.

The two subpopulations of *Xanthosia scopulicola* are also considered to be large and non-isolated, and thus the species is not considered severely fragmented as per IUCN (2022).

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: Continuing decline is not evident in the known subpopulations of *Xanthosia scopulicola*. Due to the preferred habitat of largely unvegetated, high, south-facing cliffs that the species occupies, neither high frequency or high severity fire are considered to be causing declines, nor are they able to be considered likely to do so in the future. The species' ecology and habitat preference also mean the species is resilient to the effects of drought and extreme rainfall events, and no evidence of these mechanisms causing non-trivial declines is known. All other threats, including anthropogenic disturbance, urban runoff and weed invasion are considered to be trivial in nature. Field observations carried out for this assessment and other available

data therefore do not demonstrate an observed, estimated, inferred, or projected continuing decline in EOO, AOO, area, extent and/or quality of habitat, number of locations or subpopulations, or number of mature individuals for *X. scopulicola*, and there is little confidence that such declines may become apparent in the future.

c) Extreme fluctuations.

Assessment Outcome: Not met.

Justification: *Xanthosia scopulicola* is unlikely to undergo extreme fluctuations as a woody shrub that is suspected to live for many years. Furthermore, the species resprouts after fire and drought and is not known to have mass recruitment events.

Criterion C Small population size and decline

Assessment Outcome: Not met.

Justification: The total population size of *Xanthosia scopulicola* is estimated to be a minimum of 2,000, but it may be much larger than this as most of the species' habitat is inaccessible and not easily surveyed. The minimum population size meets the Criterion threshold for Endangered, however *X. scopulicola* does not meet Criterion C because there is no information or evidence of an observed, estimated, inferred or projected decline in the number of mature individuals.

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

C1. An observed, estimated or projected continuing decline of at least: 25% in 3 years or 1 generation (whichever is longer) (CR); 20% in 5 years or 2 generations (whichever is longer) (EN); or 10% in 10 years or 3 generations (whichever is longer) (VU).

Assessment Outcome: Data deficient.

Justification: There is no information available on population trends for *X. scopulicola*.

C2. An observed, estimated, projected or inferred continuing decline in number of mature individuals.

Assessment Outcome: Not met.

Justification: Available data do not demonstrate an observed, estimated, inferred or projected continuing decline in the number of mature individuals, and there is little confidence that such declines may become apparent in the future.

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: Not met.

Justification. The Jamieson/Kedumba subpopulation is the largest of the two subpopulations and is estimated to exceed the threshold of ≤1000 required to meet this Subcriterion.

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

Assessment Outcome: Data deficient.

Justification: While the Jamieson/Kedumba subpopulation is considered to be the larger of the two subpopulations, it is not known what percentage of the population is in each subpopulation.

b. Extreme fluctuations in the number of mature individuals

Assessment Outcome: Not met.

Justification: *Xanthosia scopulicola* is unlikely to undergo extreme fluctuations as a woody shrub that is suspected lives for many years. Furthermore, it resprouts after fire and drought and is not known to have mass recruitment events.

Criterion D Very small or restricted population

Assessment Outcome: Not met.

Justification: The minimum population size of *Xanthosia scopulicola* is estimated to be 2,000 mature individuals, which exceeds the threshold of fewer than 1000 mature individuals required to meet Criterion D. The species does not meet Subcriterion D2 because, even though the AOO (52 km^2) is highly restricted, there is no plausible future threat that could drive the taxon to CR or EX in a very short time.

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: Not met.

Justification: The minimum population size of *X. scopulicola* is estimated to be 2,000 mature individuals, which is above the threshold needed to meet this Subcriterion.

D2. Restricted area of occupancy (typically <20 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: Not met.

Justification: *Xanthosia scopulicola* has an AOO of 52 km^2 and is known from only two threat-defined locations. However, there is considered to be no future plausible threat that could drive the taxon to CR or EX in a very short time.

Criterion E Quantitative Analysis

Assessment Outcome: Data deficient

Justification: No quantitative analysis has been carried out to assess the probability of extinction in this taxon.

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APPENDIX 1

Assessment against Biodiversity Conservation Act criteria
The Clauses used for assessment are listed below for reference.

Overall Assessment Outcome: *Xanthosia scopulicola* was found to be ineligible for listing as a threatened species as none of the Clauses were met.

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: Clause 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,	
		(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: Clause 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.		

Clause 4.5 - Low total numbers of mature individuals of species
(Equivalent to IUCN criterion D)
Assessment Outcome: Clause not met

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: Clause 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.