

***Wollemia nobilis* W.G.Jones, K.D.Hill & J.M.Allen (Wollemi Pine) (Araucariaceae)**

Distribution: Endemic to NSW

Current EPBC Act Status: Endangered

Current NSW TSC Act Status: Critically Endangered

IUCN RED LIST status: Critically Endangered

Proposed change for alignment: update EPBC Act to Critically Endangered

Conservation Advice: *Wollemia nobilis* (Wollemi Pine).

Summary of Conservation Assessment

Wollemia nobilis was found to be eligible for listing as Critically Endangered under

Criterion B via B1ab (iii) (v) and B2ab (iii) (v), Criterion C via C2 (a) (ii);

The main reasons for the species being eligible for listing in the Critically Endangered category are

- i) that the species has a very highly restricted geographic range. The area of occupancy (AOO) and extent of occurrence were estimated to be 4 km². The AOO is based on one 2 x 2 km grid cell, the scale recommended by the IUCN (2016). The species is only known to exist at one location. Continuing decline is estimated in geographic distribution (extent of occurrence and area of occupancy), area and extent and quality of habitat and the number of mature individuals;
- ii) less than 250 mature plants are known AND 90-100% of individuals are in one population.

Assessment against IUCN Red List criteria

Criterion A Population Size reduction.

Assessment Outcome: criterion not met. Data deficient.

Justification: There is insufficient data to estimate if there is a reduction in the size of the *Wollemia nobilis* population. The species is long lived (>200-400 years) (DEC 2006) but has only been known for just over 20 years. Therefore, the species is not eligible for listing in any category under this criterion and is data deficient.

Criterion B Geographic range.

Assessment Outcome: Critically Endangered under Criterion B1 (a) (b) (iii) (v); B2 (a) (b) (iii) (v).

Justification: The geographic distribution of *Wollemia nobilis* is very highly restricted. The extent of occurrence is 4 km², and the area of occupancy (AOO) is 4 km². The AOO is based on one 2 x 2 km grid cell, the scale recommended by the IUCN (2016). and at least 2 of the following:

a) the population or habitat is observed or inferred to be severely fragmented, or known to exist at one location.

Assessment Outcome: subcriterion met.

Justification: Only one location due to the impact of *Phytophthora cinnamomi* in existing wild catchment. The population is not considered to be severely fragmented.

b) a projected or continuing decline is observed, estimated or inferred.

Assessment Outcome: subcriterion met.

Justification: A projected continuing decline is inferred in (iii) quality of habitat, and (v) number of mature individuals. This is mainly due to the impact on the species of *Phytophthora cinnamomi* that is known to be present in the wild catchment at Site 1. The species is known to be susceptible to this pathogen based on glasshouse trials. Infected

trees in the wild show evidence of dieback of branches. There is no effective control treatment for this pathogen but treatment by injection of phosphinate for infected trees may enhance the survival of individuals.

c) extreme fluctuations:

Assessment Outcome: subcriterion not met.

Justification: The species is considered to be very long-lived with a multitemmed habit and evidence of extensive fire scars on almost all adult plants. Recruitment of new adults is thought to occur through gap colonisation, but the spatial scale of appropriate gaps and the time frames for recruitment are unknown.

Criterion C Small population size and decline.

Assessment Outcome: Critically Endangered via C2a.ii.

C1 An estimated continuing decline of at least a certain rate in 3, 5 or 10 years or 1, 2 or 3 generations, whichever is longer.

Assessment Outcome: subcriterion not met.

Justification: data deficient. No data available on decline. The species is long lived (>200-400 years) (DEC 2006) but has only been known for just over 20 years.

C2. Continuing decline in number of mature individuals:

Assessment Outcome: subcriterion met.

Justification: A projected continuing decline is inferred in (iii) quality of habitat, and (v) number of mature individuals. This is mainly due to the impact on the species of *Phytophthora cinnamomi* that is known to be present in the wild catchment at Site 1. The species is known to be susceptible to this pathogen based on glasshouse trials. Infected trees in the wild show evidence of dieback of branches. There is no effective control treatment for this pathogen but treatment by injection of phosphinate for infected trees may enhance the survival of individuals.

And one of the following three:

(a)(i) the number of mature individuals in each population is less than certain thresholds:

Assessment Outcome: subcriterion met at Endangered threshold.

Justification: Total population size is estimated to be less than 100 mature plants.

(a)(ii) the % mature individuals in one population is 90-100%.

Assessment Outcome: subcriterion met at Critically Endangered threshold.

Justification: all mature individuals occur in one population.

b) Extreme fluctuations in the number of mature individuals

Assessment Outcome: subcriterion not met.

Justification: The species is considered to be very long-lived with a multitemmed habit and evidence of extensive fire scars on almost all adult plants. Recruitment of new adults is thought to occur through gap colonisation, but the spatial scale of appropriate gaps and the time frames for recruitment are unknown.

Criterion D Very small or restricted population.

Assessment Outcome: Endangered via D1

D1. Number of mature individuals.

Assessment Outcome: subcriterion met at Endangered threshold.

Justification: Population size is estimated to number fewer than 250 mature individuals, but more than 50 mature individuals.

D2.

Assessment Outcome: subcriterion met.

Justification: The area of occupancy is very restricted.

The AOO for *Wollemia nobilis* is very restricted (4 km²), and there are fewer than 5 locations. It is possible that the impact of *Phytophthora cinnamomi* may be quite sudden and triggered by drought or heat stress of infected plants, and hence “prone to the effects of human activities or stochastic events within a very short time period in an uncertain future, and is this capable of becoming Critically Endangered or even extinct on a very short time period” (IUCN 2001).

Criterion E Quantitative Analysis.

Assessment Outcome: Data deficient.

Justification: Insufficient data to assess.

Description

NSW Scientific Committee (2015) state that “*Wollemia nobilis* W.G.Jones, K.D.Hill & J.M.Allen (family Araucariaceae) is described by Royal Botanic Gardens and Domain Trust PlantNET as: “Trees to 40 m high; trunk to 1 m diam.; bark densely (sic) covered with dark brown nodules or tubercles. Leaves on leading shoots, arranged in 5–8 spiral rows, narrow-triangular, 3–10 mm long, keeled, acute, pungent; leaves on juvenile lateral shoots (growing horizontally away from the leading shoots) spirally distichous, linear to narrow-triangular, leathery, rounded or obtuse, upper surface deep green, lower surface glaucous, 2–8 cm long, 2–5 mm wide; leaves on adult lateral shoots arranged in 4 regular vertical rows, narrow-oblong, leathery, rounded, dull pale to mid-green, 1–4 cm long, 4–8 mm wide. Male cones to 10.9 cm long, 19 mm diam. Female cones 5–8 cm long diam. Seeds pale brown, 4–6 mm wide including the wing.”

Distribution

NSW Scientific Committee (2015) state that “*Wollemia nobilis* is endemic to New South Wales and is restricted to four small patches in a single location in Wollemi National Park. It grows “in warm temperate rainforest typical of the canyons in the Blue Mountains and Wollemi National Parks” (Benson and Allen 2007). The species is thought to have declined over millions of years in a similar pattern to other members of the Araucariaceae in response to changes in climate, the evolution and dominance of angiosperms and probable impacts of increasing fire frequency and intensity (DEC 2006). *Wollemia nobilis* has been successfully propagated and is available commercially. In addition, an *ex situ* living collection and seed bank are maintained by the Royal Botanic Gardens and Domain Trust (DEC 2006).”

Ecology

NSW Scientific Committee (2015) state that “*Wollemia nobilis* is long-lived with a multi-stemmed tree habit (Hill 1997; DEC 2006; Benson and Allen 2007). A growth ring analysis of an individual fallen stem suggested the stem was some 400 years old (Banks 2002) and the plant from which the stem fell is still alive and another stem has become the apical dominant. Mature plants produce both male and female cones and seed release occurs annually, although there is some variation in the number of cones produced (Zimmer *et al.* 2015a). The species maintains a very slow growing juvenile bank of plants (which themselves are predicted to live for many decades) and new recruits from each annual seed fall help to maintain this juvenile bank (Zimmer *et al.* 2014). These juvenile plants would be expected to have accelerated growth should any canopy gaps occur in their habitat. No persistent soil seed bank is evident. Dispersal of seeds occurs locally by wind and gravity, but there may be occasional longer distance dispersal by water or by movement of cones by cockatoos.” “Fewer than

100 mature individuals are known in the wild (DEC 2006) and the estimated total number of mature individuals is considered to be very low. Fewer than 300 juvenile plants occur in the wild (Zimmer *et al.* 2014)."

Threats

NSW Scientific Committee (2015) state that "While fire severity and frequency are considered to be factors in the historical decline of the Araucariaceae (including *Wollemia*), *W. nobilis* occurs in areas that periodically burn and virtually all mature individuals show extensive fire scarring. The presence of a large root bole, epicormic buds (Burrows *et al.* 2003) and multiple replacement stems (Hill 1997) suggest that individual plants can survive a fire. The sensitivity of the species to frequent fire or high severity fires is unknown, although Zimmer *et al.* (2015b) demonstrated the capacity of juvenile plants to resprout epicormically after experimental burning. Given the flammability of the litter of *W. nobilis*, Zimmer *et al.* (2015b) suggest lower severity fires may play a role in favouring *W. nobilis* juveniles over angiosperm competitors in rainforest. *Wollemia nobilis* W.G.Jones, K.D.Hill & J.M.Allen is known to be susceptible to the plant pathogen *Phytophthora cinnamomi* (Bullock *et al.* 2000) which is present at the largest remaining site for the species. *Wollemia nobilis* individuals have shown symptoms of the disease on their foliage, leading to branch dieback and death and stem death. To date, no individuals have died. There is no comprehensive control treatment for this pathogen but treatment by injection of phosphonate into infected trees has been trialled to enhance the survival of individuals. Work is also underway on the most effective way to apply phosphonate in the wild. Unauthorised visitation to the wild site is a threat as it may result in the introduction of new pathogens and the spread of *P. cinnamomi* across the wild population. An increase in fire frequency or fires of a severity that scorch all above ground stems is likely to be detrimental to the species."

Conservation and Management Actions

The following information is based on the national recovery plan for *Wollemia nobilis* (DEC 2006) and updated information from the Wollemi Pine Recovery Team.

Habitat loss, disturbance and modification

- restrict access to known locations as per DEC (2006).
- Maintain closure of area containing wild population to limit spread of pathogens and further introductions.

Invasive species

- In the known sites and associated habitat, identify and remove/control weeds that may be a threat to the species, using appropriate methods.
- Continue the development of techniques to enhance the ability of the species to cope with *P. cinnamomi* infections in the wild.

Fire management

- Develop fire plans for the species to ensure fires do not adversely impact on the species in the wild or at any new translocation sites. This requires consideration of all components of the fire regime and adherence to any fire frequency thresholds developed in the NSW Rural Fire Service Bush Fire Code Threatened Species Hazard Reduction list for plants.
http://www.rfs.nsw.gov.au/__data/assets/pdf_file/0017/24335/ThreatenedSpeciesHazardReductionList-Part1-Plants.pdf
- Continue experimental testing of the impact of low severity fires on juvenile plants and associated rainforest taxa.

Ex situ conservation

- Maintain both *ex situ* living and seed collections representative of the genetic diversity expressed in the wild.
- Develop a plan for further translocations into the wild as backups for the single wild population.

Stakeholder Management

- maintain active recovery team for conservation management and protection of the species with engagement of land managers and relevant experts.

Survey and Monitoring priorities

- Maintain ongoing monitoring of known sites to determine population health and trends in population size over time.
- Maintain ongoing monitoring of the impact of pathogens on habitat quality and plant growth and survival.
- Maintain monitoring of growth and survival of plants at experimental translocation site.

Information and research priorities

- Undertake further ecological research into the species' life history, ecology and germination requirements relevant to the persistence of the species. Priorities include impacts of low severity fires on juvenile plants, factors controlling ongoing seed production, the role of gap recruitment and the degree and distribution of genetic variation in the wild population.
- Investigate methods and possibilities for most effective translocation to new wild sites.

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Zimmer HC, Auld TD, Hughes L, Offord CA, Baker PJ (2015b) Fuel flammability and fire responses of juvenile canopy species in a temperate rainforest ecosystem. *International Journal of Wildland Fire* **24**, 349–360.

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Final Determination

The Scientific Committee, established by the *Threatened Species Conservation Act* 1995, (the Act) has made a Final Determination to list the Wollemi Pine, *Wollemia nobilis* W.G.Jones, K.D.Hill & J.M.Allen as a CRITICALLY ENDANGERED SPECIES in Part 1 of Schedule 1A of the Act and, as a consequence, to omit reference to *Wollemia nobilis* W. Jones, K. Hill & J. Allen from Part 1 of Schedule 1 (Endangered species) of the Act. Listing of Critically Endangered species is provided for by Part 2 of the Act.

The Scientific Committee has found that:

1. Wollemi Pine, *Wollemia nobilis* (family Araucariaceae) was listed as Endangered at the inception of the *Threatened Species Conservation Act* in 1995. At the time of listing the Critically Endangered category did not exist. Since this original listing the plant pathogen *Phytophthora cinnamomi* has been found in the wild population and threatens the long-term survival of the species. In addition, the species has recently been assessed by IUCN as critically endangered (Thomas 2011). Consequently, the Scientific Committee has undertaken a review of the conservation status of the species to inform the current listing status of the species under the *Threatened Species Conservation Act* 1995.
2. *Wollemia nobilis* W.G.Jones, K.D.Hill & J.M.Allen (family Araucariaceae) is described by Royal Botanic Gardens and Domain Trust PlantNET as: “Trees to 40 m high; trunk to 1 m diam.; bark densely (sic) covered with dark brown nodules or tubercles. Leaves on leading shoots, arranged in 5–8 spiral rows, narrow-triangular, 3–10 mm long, keeled, acute, pungent; leaves on juvenile lateral shoots (growing horizontally away from the leading shoots) spirally distichous, linear to narrow-triangular, leathery, rounded or obtuse, upper surface deep green, lower surface glaucous, 2–8 cm long, 2–5 mm wide; leaves on adult lateral shoots arranged in 4 regular vertical rows, narrow-oblong, leathery, rounded, dull pale to mid-green, 1–4 cm long, 4–8 mm wide. Male cones to 10.9 cm long, 19 mm diam. Female cones 5–8 cm long diam. Seeds pale brown, 4–6 mm wide including the wing.”
3. *Wollemia nobilis* is endemic to New South Wales and is restricted to four small patches in a single location in Wollemi National Park. It grows “in warm temperate rainforest typical of the canyons in the Blue Mountains and Wollemi National Parks” (Benson and Allen 2007). The species is thought to have declined over millions of years in a similar pattern to other members of the Araucariaceae in response to changes in climate, the evolution and dominance of angiosperms and probable impacts of increasing fire frequency and intensity (DEC 2006). *Wollemia nobilis* has been successfully propagated and is available commercially. In addition, an *ex situ* living collection and seed bank are maintained by the Royal Botanic Gardens and Domain Trust (DEC 2006).
4. The geographic distribution of *Wollemia nobilis* is very highly restricted. The extent of occurrence for *W. nobilis* is 4 km² based on a minimum convex polygon enclosing all known occurrences of the species, the method of assessment recommended by IUCN (2014). The area of occupancy (AOO) is estimated to be 4 km² based on a single 2 x 2 km grid cell, the scale recommended for assessing AOO by IUCN (2014).
5. *Wollemia nobilis* is long-lived with a multi-stemmed tree habit (Hill 1997; DEC 2006; Benson and Allen 2007). A growth ring analysis of an individual fallen stem suggested the stem was some 400 years old (Banks 2002) and the plant from which the stem fell is still alive and another stem has become the apical dominant. Mature plants produce both male and female cones and seed release occurs annually, although there is some variation in the number of cones produced

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(Zimmer *et al.* 2015a). The species maintains a very slow growing juvenile bank of plants (which themselves are predicted to live for many decades) and new recruits from each annual seed fall help to maintain this juvenile bank (Zimmer *et al.* 2014). These juvenile plants would be expected to have accelerated growth should any canopy gaps occur in their habitat. No persistent soil seed bank is evident. Dispersal of seeds occurs locally by wind and gravity, but there may be occasional longer distance dispersal by water or by movement of cones by cockatoos.

6. Fewer than 100 mature individuals are known in the wild (DEC 2006) and the estimated total number of mature individuals is considered to be very low. Fewer than 300 juvenile plants occur in the wild (Zimmer *et al.* 2014).
7. While fire severity and frequency are considered to be factors in the historical decline of the Araucariaceae (including *Wollemia*), *W. nobilis* occurs in areas that periodically burn and virtually all mature individuals show extensive fire scarring. The presence of a large root bole, epicormic buds (Burrows *et al.* 2003) and multiple replacement stems (Hill 1997) suggest that individual plants can survive a fire. The sensitivity of the species to frequent fire or high severity fires is unknown, although Zimmer *et al.* (2015b) demonstrated the capacity of juvenile plants to resprout epicormically after experimental burning. Given the flammability of the litter of *W. nobilis*, Zimmer *et al.* (2015b) suggest lower severity fires may play a role in favouring *W. nobilis* juveniles over angiosperm competitors in rainforest.
8. *Wollemia nobilis* W.G.Jones, K.D.Hill & J.M.Allen is known to be susceptible to the plant pathogen *Phytophthora cinnamomi* (Bullock *et al.* 2000) which is present at the largest remaining site for the species. *Wollemia nobilis* individuals have shown symptoms of the disease on their foliage, leading to branch dieback and death and stem death. To date, no individuals have died. There is no comprehensive control treatment for this pathogen but treatment by injection of phosphonate into infected trees has been trialled to enhance the survival of individuals. Work is also underway on the most effective way to apply phosphonate in the wild. Unauthorised visitation to the wild site is a threat as it may result in the introduction of new pathogens and the spread of *P. cinnamomi* across the wild population. An increase in fire frequency or fires of a severity that scorch all above ground stems is likely to be detrimental to the species. "Infection of native plants by *Phytophthora cinnamomi*" is listed as a Key Threatening Process under the Act.
9. *Wollemia nobilis* W.G.Jones, K.D.Hill & J.M.Allen is eligible to be listed as a Critically Endangered species as, in the opinion of the Scientific Committee, it is facing an extremely high risk of extinction in New South Wales in the immediate future as determined in accordance with the following criteria as prescribed by the *Threatened Species Conservation Regulation* 2010:

Clause 7 Restricted geographic distribution and other conditions

The geographic distribution of the species is estimated or inferred to be:

- (a) very highly restricted,
- and
- (d) a projected or continuing decline is observed, estimated or inferred in either of the key indicators:
 - (a) an index of abundance appropriate to the taxon, or
 - (b) the geographic distribution, habitat quality or diversity, or genetic diversity.

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Clause 8 Low numbers of mature individuals of species and other conditions

The estimated total number of mature individuals of the species is:

(a) very low,

and

(d) a projected or continuing decline is observed, estimated or inferred in either of the key indicators:

(a) an index of abundance appropriate to the taxon, or

(b) the geographic distribution, habitat quality or diversity, or genetic diversity.

Dr Mark Eldridge
Chairperson
Scientific Committee

Exhibition period: 02/10/15 – 27/11/15

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