The Minister's delegate approved this Conservation Advice on 16/12/2016.

Conservation Advice

Davidsonia johnsonii

smooth davidsonia

Conservation Status

Davidsonia johnsonii (smooth davidsonia) is listed as Endangered under the *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth) (EPBC Act) effective from the 16 July 2000. The species was eligible for listing under the EPBC Act as on 16 July 2000 it was listed as Endangered under Schedule 1 of the preceding Act, the *Endangered Species Protection Act 1992* (Cwlth).

The species can also be listed as threatened under state and territory legislation. For information on the current listing status of this species under relevant state or territory legislation, see http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl.

The main factors that are the cause of the species being eligible for listing in the Endangered category are that the species has a distribution that is severely fragmented and the total population size is low.

Description

The smooth davidsonia is a bushy tree, mostly 5 - 12 m high, but specimens 18 m in height have been recorded (DEC 2004). The species is clonal and habitually occurs in clumps consisting of numerous root suckers. Trees are well-branched with dense crowns. Young growth is covered with soft, non-irritant hairs, but mature leaves are almost hairless. The leaves are alternately placed along the stems, green and glossy on the upper surface and dull green underneath. The compound leaves are usually 10 - 33 cm long with five to nine leaflets. Leaflets have evenly toothed margins and range from 2–15 cm in length and 1.5 - 6 cm in width. The leaf stalk is 2.5 - 7 cm long. Small dark-pink flowers are arranged along a flower-bearing stem, borne amongst the leaves (Harden & Williams 2000; DEC 2004). The flowers are sessile (without a basal stalk) and are usually arranged in axillary (terminal) panicles usually 100 - 200 mm long (Harden & Williams 2000), but occasionally occur as spikes (DEC 2004), located at or just below the apices of stems. Fruits mostly exhibit a flattened-ball or apple shape, however the fruits produced by one known population are larger and pear-shaped (Watson 1987 cited in DEC 2004). Fruits are typically 20 - 39 mm long, 25 - 60 mm wide and 28 - 53 mm deep, reddish-purple to purplish-black sprinkled with fine hairs, appearing smooth. The fruit has a reddish flesh, and usually two, sometimes three, seed cases. Seed cases are short and softly fibrous but rarely contain seeds (Harden & Williams 2000).

Distribution

The smooth davidsonia has a restricted and highly fragmented distribution from the Tallebudgera and Numinbah Valleys in Queensland south to Tintenbar in coastal NSW (DEC 2004; OEH 2014). The species' occurrence is not evenly distributed over its known range. While most populations occur on the coastal plain and ranges, two remote populations are located 25 - 30 km inland at Nimbin and Terania Creek in NSW (DEC 2004).

In 2016, 27 isolated populations were estimated to exist (Eliott pers. comm. 2016). This number has slightly increased from 23 in 2004 (DEC 2004) with no local extinctions known to have occurred between 2004 and 2016 (Brown pers. comm. 2016; Eliott pers. comm. 2016; Kupsch pers. comm. 2016).

All populations of the smooth davidsonia occurring in south-east Queensland occur on freehold land that is owned and managed by various private landholders. Populations in NSW occur within the following land tenures (Byron Shire Council 2010; DEC 2004; Kupsch pers. comm. 2016; OEH 2016):

- Goonengerry National Park, Snows Gully Nature Reserve, Nightcap National Park and Duroby Nature Reserve (Hogan's Scrub), which are managed by the NSW National Parks and Wildlife Service (NSW Office of Environment and Heritage);
- Pocket Road Reserve, which is managed by Byron Shire Council (plants extend onto private property); and
- freehold land owned and managed by various private landholders.

The smooth davidsonia is known at an altitudinal range of 15–270 m above sea level (a.s.l.), with the highest locations being in NSW at Huonbrook and Wilson's Creek, near Mullumbimby, above 250 m a.s.l. (Byron Shire Council 2010; DEC 2004; Watson 1987 cited in DEC 2004). The species occurs on landforms that include moderate to gentle slopes, creek flats and gullies. Aspect is most commonly south-western to south-eastern, although at least one known site has been recorded at a north-facing location (DEC 2004).

The species occurs on soil derived from a variety of parent materials. In the Tweed and Broken Head areas, the smooth davidsonia occurs on shallow, clay-loam podzol, with surface rocks, weathered from metasediments of the Neranleigh- Fernvale complex. Other sites are on soils derived from the basalts and rhyolites of the Lamington volcanics. Occurrences of the species are common on soils formed at the boundaries of Lismore basalt and Nimbin rhyolite (DEC 2004; Eliott pers. comm. 2016; Harden & Williams 2000; Kupsch pers. comm. 2016).

Relevant Ecology

In 2016, records suggest that a majority of the known smooth davidsonia populations is found in wet sclerophyll forests with a smaller number of records known from subtropical rainforest (complex notophyll vine forest) and in vegetation ecotones in between sclerophyll and rainforest ecological communities (Eliott pers. comm. 2016; Kupsch pers. comm. 2016; McKinley & Stewart 1999 cited in DEC 2004). Dominant species in wet sclerophyll forest ecological communities in which the species occurs include *Eucalyptus grandis* (flooded gum) and *Lophostemon confertus* (brush box), while numerous co-dominant species in the subtropical rainforest ecological communities include the listed Vulnerable *Hicksbeachia pinnatifolia* (monkey nut), *Diploglottis australis* (native tamarind), *Acacia melanoxylon* (black wattle), *Castanospora alphandii* (brown tamarind) and *Omalanthus populifolius* (bleeding heart tree) (Harden & Williams 2000).

The species has also been recorded in isolated clumps in paddocks or in vegetation regrowth dominated by invasive weeds (DEC 2004; Eliott pers. comm. 2016; Kupsch pers. comm. 2016). Having largely been cleared for agriculture and development, these ecological communities are scarce within the species' range. All lowland rainforest ecological communities, wet sclerophyll forests and regrowth on land which formerly supported these ecological communities within and surrounding the range of the smooth davidsonia should be regarded as potential habitat (DEC 2004).

Smooth davidsonia flowering predominantly occurs in October and November (Harden & Williams 2000). Flowering at some sites has been detected as early as September, whilst at other sites flowering has not commenced until November (DEC 2004). In addition, while considerable variation in the seasonal timing of flowering/fruiting has also been observed between populations of the smooth davidsonia (Byron Shire Council 2010; Floyd 1989; Harden & Williams 2000; Watson 1987 cited in DEC 2004), the flowering of individuals within each population is synchronous (DEC 2004; Eliott pers. comm. 2016).

Variation in flower structure of the species has been observed between sites (Eliott pers. comm. 2016; Watson 1987 cited in DEC 2004). In some populations, the female reproductive organs of

flowers are normally comprised of two fused carpels with four to five ovules (up to seven observed in one known population) per carpel. However, in some specimens in other populations, the female organs are underdeveloped, almost vestigial (DEC 2004; Harden & Williams 2000). Many flowers have been found to be reproductively infertile (Eliott et al., 2016; DEC 2004; Harden & Williams 2000), although research has found that pollen from some individuals/populations is viable (Eliott pers. comm. 2016).

The pollination ecology of smooth davidsonia and its flowers is not well understood (Eliott et al., 2016). Various unidentified native bee species and exotic bee species, most notably the European honey bee (*Apis mellifera*), beetle species and ant species have been observed visiting smooth davidsonia flowers (Eliott pers. comm. cited in DEC 2004). At peak flowering time in some populations, the flowers attract large numbers of pollinators (Eliott et al., 2016).

Limited observation of ex situ cultivated individuals suggests that the smooth davidsonia is moderately slow growing and that first fruiting by individuals occurs approximately 10 years after propagation, at a height of 2 – 3 m (DEC 2004). The commencement of fruit development has been recorded as early as December (Floyd 1989) and ripe fruit has been recorded from February to June (Byron Shire Council 2010; Harden & Williams 2000). Trees generally produce abundant crops of fruit (Eliott et al., 2016). Variation in fruit production and shape has been observed between populations (Kupsch pers. comm. 2016; Watson 1987 cited in DEC 2004) and variations in the shapes of particular fruits are distinctively characteristic of the individuals or populations that produce them (Kupsch pers. comm. 2016).

Fruits of the species may develop pyrenes (an internal layer of a drupe that would normally surround the single seed), but invariably contain no seed (Eliott et al., 2016; DEC 2004; Harden & Williams 2000). According to Rossetto (pers. comm. cited in DEC 2004), there have been only two instances of a seed being found within a smooth davidsonia fruit, however these observations are anecdotal and have not been documented (Eliott et al., 2016). Possible explanations for the low incidence of seed production include severe habitat fragmentation in which subpopulations of compatible plants and pollinators are isolated from each other resulting in a lack of cross-pollination; no transfer of pollen from anther to stigma; lack of production of pollen or viable pollen; self-incompatibility mechanisms; and early abortion of developing embryo (DEC 2004; Eliott pers. comm. 2016). Those individuals or populations observed with the best development of female organs in the flowers have also been observed to be the heaviest fruit-bearing stands (DEC 2004).

Reproduction in the smooth davidsonia is only known to occur through root suckering (Eliott et al., 2016; DEC 2004; Harden & Williams 2000). Observations of all occurrences the species indicate that root suckering is particularly prolific at sites where soil has been disturbed or plants have been slashed (DEC 2004; Kupsch pers. comm. 2016). This mode of reproduction has enabled the species to survive even when surrounding vegetation has been completely cleared. Some sites appear to have regrown following the abandonment of pasture or banana plantations (DEC 2004; Kupsch pers. comm. 2016). The age at which the production of root suckers can commence (Kupsch pers. comm. 2016), and the extent to which soil disturbance and/or physical root damage is necessary, is unknown (DEC 2004). Root suckers develop strongly in disturbed areas, but do not appear to develop strongly in heavily shaded environments. The extent to which shading and soil disturbance interact to influence the initiation and development of sucker growth is not well understood. No other forms of vegetative reproduction, such as layering, have been observed (DEC 2004).

Smooth davidsonia populations vary in size from a single stem of an individual plant with a small number of root suckers growing around it to extensive monocultural stands or clumps to groups of clumps (DEC 2004; Eliott pers. comm. 2016; Kupsch pers. comm. 2016). Genetic research conducted over the last 15 years has shown that clumps are clonal (DEC 2004; Eliott pers. comm. 2016). The single stems found within clumps are root suckers known as ramets. These ramets are vegetative clones of an original genetic individual known as a genet (DEC 2004; Eliott pers. comm. 2016). Some clumps, particularly those occurring in forest ecological communities, are extensive and radiate from an original stem that may be many hundreds of years old or may have perished (Eliott pers. comm. 2016; Kupsch pers. comm. 2016).

Each of the estimated 27 known populations is likely to be genetically isolated and highly differentiated from each other, although further genetic research is required to verify this (Eliott pers. comm. 2016). However, given that each population consists of one or a very small number of genetically distinct individuals, the total population of the species, therefore, consists of a very small number of individuals and that genetic variation within the species is critically low (DEC 2004; Eliott et al., 2016; Eliott pers. comm. 2016). The low number of individuals/clumps/ populations and, therefore, low genetic diversity in the entire species, in conjunction with the virtual (contemporary) inability of the species to sexually reproduce and to colonise new areas, means that the species has greatly reduced biological fitness and ability to respond to alterations in its environment, including climate change. Therefore, the evolutionary potential of the species is likely to be limited (DEC 2004; Eliott pers. comm. 2016; Rossetto et al., 2004).

Threats

The smooth davidsonia is threatened by habitat loss and fragmentation, invasive species, physical damage to and removal of fruits and vegetative regrowth of the species which places the smooth davidsonia at risk. These threats are their effects on the species are described in the table below. The threats outlined below have corresponding conservation managements.

Table 1 – Threats impacting the smooth davidsonia in approximate order of severity of risk, based on available evidence.

Threat factor	Threat status	Evidence base
Habitat loss, fragmentation or degradation		
Land clearing for property, infrastructure and agricultural development	known current	Clearing of habitat for various forms of land development, including agriculture, road construction and upgrades, and industrial and residential development, has led to the destruction, fragmentation and isolation of smooth davidsonia populations and the historical decline of the species across its natural range (DEC 2004). The threat of habitat clearing and fragmentation is widespread and ongoing (Byron Shire Council 2010; Eliott et al., 2013; OEH 2014; Kupsch pers. comm. 2016). At least six small populations, some consisting as few as one primary stem with a few root suckers, are particularly vulnerable to routine agricultural or road maintenance activities or potential land-use changes (Kupsch pers. comm. 2016). Most importantly, the removal of an individual, clump (genet) or population of the species will deplete the species' already limited genetic variation (Eliott pers. comm. 2016). Moreover, there is a small but fundamental risk that occasionally formed seed produced by an individual of the species could be destroyed, thereby destroying an individual/clump/ population that is capable of sexual reproduction and a potential, vital contributor to the survival and recovery of the species (Eliott et al., 2016; Eliott pers. comm. 2016).Other consequences of land clearing and diminishing habitat patch sizes are edge effects and the alteration of the fire ecology of the species' forest habitats (DEC 2004).

Invasive species		
Weed invasion and competition	known current	Small areas of fragmented habitat are prone to edge effects, particularly weed invasion and competition (DEC 2004; OEH 2014). Many records of the smooth davidsonia are from areas of regrowth vegetation, small patches of fragmented habitat or on the edges of forests, and are threatened by weed invasion and competition (DEC 2004; Kupsch pers. comm. 2016; OEH 2014 and 2016). The most common weed species that have affected the species and its habitat are lantana (*Lantana camara*), the camphor laurel (*Cinnamomum camphora*) and the groundsel bush (*Baccharis halimifolia*) (Barry & Thomas 1994; Byron Shire Council 2010; DEC 2004). At a number of locations on private land, lantana and/or native vines have be known to grow over smooth davidsonia individuals, competing for light and resources and physically weighing them down (DEC 2004; OEH 2014).
Physical damage to individuals of the species		
Browsing and the effect of soil compaction caused by livestock	known current	Cattle (*Bos taurus*) are known to browse of the leaves of smooth davidsonia occurring on private lands (Byron Shire Council 2010; Kupsch pers. comm. 2016; OEH 2014 and 2016). Populations occurring in paddocks and on the edges of forests are also exposed to browsing by goats (*Capra hircus*) and the adverse effects of soil compaction resulting from frequent trampling and camping by cattle (DEC 2004; Kupsch pers. comm. 2016).
Frequent use of mechanical vegetation control methods	potential current	Continual, frequent and inadvertent slashing of individuals of the species during routine vegetation/weed control activities employing traditional control methods, for example the use of tractors or brush hooks along road reserves, may eventually exhaust an individual's capacity to survive (DEC 2004; Kupsch pers. comm. 2016; OEH 2014).
Frequent foliar applications of herbicide to control weeds	potential current	Continual, frequent and inadvertent applications of herbicide to individuals of the species during routine weed (e.g. lantana) control activities may exhaust an individual's capacity to survive (DEC 2004; OEH 2014).

Removal of fruits and vegetative regrowth		
Harvesting of fruits for the bush food industry and root suckers for vegetative propagation	known current	Fruit from wild populations of the smooth davidsonia has been known to be collected illegally for the bush food industry (Byron Shire Council 2010; DEC 2004; Kupsch pers. comm. 2016; OEH 2014), although this threat has diminished over the last 10 – 15 years (Kupsch pers. comm. 2016). Given that the species is not known to produce fertile seed, collection of fruit from individuals is likely to pose little threat to the species. However, given that it is possible that an individual may produce seed, fruit collection could destroy a resource of particular conservation and scientific value (DEC 2004). Damage to individuals can also occur during fruit collection, especially if they are climbed or ladders are used to reach the fruit (DEC 2004). Given that individuals of the species rely on vegetative propagation, through the growth of root suckers, to persist over long time periods, the continual removal of root suckers from an individual is likely to reduce its ability to persist (Eliott pers. comm. 2016; Kupsch pers. comm. 2016). The collection of suckers as propagation material for the bush food and nursery industries has been known to cause initial damage to individuals of the species, with the potential for disease to enter the individual through the damaged area (DEC 2004).
Fire		
Moderate to high-intensity wild fires and hazard reduction burning	potential current	As with most rainforest and wet sclerophyll species, the smooth davidsonia is likely to be sensitive to fire. Fire is probably the biggest risk to those sites within a larger remnant ecological community where there is a potential for the development of a substantial fuel load. Fire encroachment into these areas is possible in high fire-danger conditions. It is likely that any damage will be irreversible if fires are of high intensity or frequency (DEC 2004). The use of fire to manage hazardous forest fuel loads may have a negative impact on populations and individual clumps (genets) of the species (DEC 2004; OEH 2014; Kupsch pers. comm. 2016).

Conservation Actions

Conservation and Management priorities

Habitat loss, fragmentation or degradation

- Protect areas of known occurrence and potential habitat from clearing and inappropriate disturbance. In accordance with relevant Commonwealth, state and local government environmental legislation, assess all activities that may result in the direct or indirect removal, fragmentation or degradation of smooth davidsonia populations or their habitats.
- Ensure that adequate targeted surveys for the species and habitat assessments, including searching under dominant weeds, are conducted prior to assessing

development or rezoning applications that affect known or potential occurrences or habitats of the species.

- Rehabilitate ecological communities where individuals/clumps or populations of the species have been exposed by habitat removal.
- Continue to negotiate for protection of populations on private land through legislative protection and additional protections such as conservation agreements and covenants.

Invasive weeds

- Continue to develop and implement site-specific management plans for smooth davidsonia populations (OEH 2014 and 2016). These plans should integrate appropriate bush regeneration and weed-control techniques to control relevant weed species in, and adjacent to, areas where populations of the species occur with broader regional solutions aimed at reducing the sources of weed propagules in the surrounding areas (DEC 2004).
- Determine the feasibility of weed control techniques, such as cutting/scraping and painting lower main stems with concentrated systemic herbicide or applying a foliar spray of diluted systemic herbicide, before clearing the infestation of weeds from a site.
- Precautionary measures to avoid incidental damage to smooth davidsonia individuals through mechanical or herbicide spraying weed control methods should be incorporated in site-specific weed management plans and should be implemented.
- Record the timing, climatic conditions and weed control methods applied to control specific weed species at specific sites.

Physical damage to individuals of the species

- Ensure that all land users are aware of the species' occurrence and implement measures to avoid damaging known smooth davidsonia populations during works.
- Continue to prevent accidental destruction of populations of smooth davidsonia by maintaining signage, which indicates the occurrence of populations and the importance of avoiding damage to them or their habitats, at relevant sites.
- Continue to install and maintain fencing and signage to exclude machinery.
- Develop and implement site-appropriate strategies, including exclusion fencing, to protect populations of the species from browsing and trampling by livestock (OEH 2014 and 2016).

Harvesting of fruits and other propagation material

- Continue to regulate the collection of fruit and vegetative propagation material from wild smooth davidsonia populations to ensure that all collection activity is approved under relevant state government legislation.
- Continue to promote sustainable fruit collection practices that do not contribute to a reduction in the genetic diversity of the species.

Breeding, propagation and other ex situ recovery action

- Maintain private ex situ living collections of propagated/cultivated individuals that are representative of all smooth davidsonia populations and assist in conservation efforts to improve the genetic diversity of the species by attempting to promote cross-pollination of genetic individuals in order to facilitate the potential production of fertile seed (Kupsch pers. comm. 2016).

- Continue to devise, implement and maintain a state government managed ex situ program and facility for the propagation/cultivation of collected vegetative material and maintenance of a living collection of propagated individuals that represents the genetic diversity of all of the known populations of the species. This program should include the recombination of genets (genotypes) to facilitate cross-pollination and potentially produce fertile seeds and employ proven propagation and cultivation methods (Brown pers. comm. 2016; Eliott pers. comm. 2016).
- Establish and maintain long-term facilities to propagate and store a living collection of the species.
- Record the source (individual/clump/population) from which vegetative material is collected.
- Consider implementing a programme to translocate cultivated individuals of the species to areas of suitable habitat in accordance with translocation protocols recommended in Vallee et al. (2004).

Fire

- Develop and implement a fire management strategy for the smooth davidsonia founded on the following principles:
  - Ensure fuel reduction and other planned fires are not implemented at sites where the smooth davidsonia occurs.
  - Where appropriate, employ fuel reduction activities and other protective measures at strategic locations in the vicinity of smooth davidsonia populations to reduce the potential adverse impacts of wildfire on those populations. Ensure these fuel reduction activities are well planned and implemented, they are of low intensity and do not constitute an increased risk (e.g. through escape of planned fires).
  - Ensure fire management maps include the locations of known smooth davidsonia populations.

Stakeholder Engagement

- Continue to notify and maintain the awareness of all relevant landholders/managers, local governments, relevant road construction and maintenance contractors, natural resource management organisations, traditional owners, non-government organisations and local conservation groups about the location of the species and provide advice about its recovery and management requirements.
- Continue to develop and maintain strong associations between the relevant state government authorities, traditional owners, local governments, natural resource management organisations, non-government organisations and local conservation groups to benefit continued regular monitoring of known populations and surveying for the species in suitable habitats.
- Identify opportunities for, and promote and support the involvement of community groups and volunteers in recovery activities for the species.
- Continue to liaise with all local governments within the species' range to assist in the identification and mapping of this species.
- Continue to educate consumers about the need to avoid purchasing smooth davdsonia plums from unlicensed suppliers who may support unlawful collection of fruits from wild populations of the species.

- Continue to educate consumers about the need to avoid purchasing cultivated plants of the species from unlicensed suppliers who may support unlawful collection of vegetative propagation material from wild populations of the species.
- Continue to electronically update available information about the species, including information about its appearance, habitat, threats, recovery actions and the importance of locating, monitoring and protecting populations over the long-term.

Survey and monitoring priorities

- Continue annual monitoring of known populations of the smooth davidsonia and their habitats. Collect demographic information, including recruitment and mortality, timing of life history stages, most notably the age of first fruit production, peak flowering and fruiting times, variation in flower and fruit production between sites and between years, affects of disturbances to the population, floristic and environmental information relevant to the condition of the ecological community, and the effects of implemented management regimes (DEC 2004).
- Continue to conduct systematic and comprehensive surveys of all potential smooth davidsonia habitat to locate any new or unconfirmed populations.

Information and research priorities

- Continue to develop and support systematic research on the key biological functions of the smooth davidsonia. The topics for research that will be most beneficial to the conservation of the species are: the breeding system of the species; explanations for the low incidence of seed produced by the species; genetic diversity within and between populations; essential life-history stages; the pollination ecology of the species; and the longevity of individual genets and ramets; the long-term evolutionary trajectory of the species; the species' fire ecology; and the potential effects of global climate change on the species.
- Develop a habitat suitability model for the species to determine the ecological/ environmental indices responsible for the species' distribution, and how it may change due to the impending threats. This requires a reasonably high number of presence records and the environmental variables recorded at those corresponding sites chosen at random (Guisan & Zimmermann 2000).
- Develop a predictive model of the species' geographical distribution based on a reasonably sized data-set of the species' records and the environmental variables associated with those records (Phillips et al., 2006).
- Conduct laboratory and field trials to identify the key requirements for successful vegetative propagation and cultivation under varying environmental conditions and using varying propagation and cultivation techniques.
- Investigate options for linking, enhancing or establishing additional populations.
- Analyse the effectiveness of management actions and the need to adapt them if necessary. Collate and analyse census data, compare with management histories and conduct population viability analyses.

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