Australian Government
Department of Agriculture, Water and the Environment

Conservation Advice for *Olearia flocktoniae* (Dorrigo Daisy-bush)

In effect under the *Environment Protection and Biodiversity Conservation Act 1999* from 23 November 2021.

This document provides a foundation for conservation action and further planning.

Photograph of *Olearia flocktoniae* (Dorrigo Daisy-bush) © Copyright, M. Fagg, Australian National Botanic Gardens

Conservation status.

Olearia flocktoniae (Dorrigo Daisy-bush) is listed in the Endangered category of the threatened species list under the *Environment Protection and Biodiversity Conservation Act 1999* (Cwth) (EPBC Act) effective from 16 July 2000. The species is eligible for listing because prior to the EPBC Act, it was listed as Endangered under the *Endangered Species Protection Act 1992* (Cwlth).

The main factors that make the species eligible for listing in the Endangered category are its restricted distribution (small area of occupancy and extent of occurrence), a small number of locations and that the specific requirements for habitat disturbance have resulted in a history of subpopulation extinction and ongoing declines if not managed.

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 the Species Profile and Threat Database.

Species information

Taxonomy

Conventionally accepted as *Olearia flocktoniae* (Maiden & Betch 1909). Dorrigo Daisy-bush belongs to the Asteraceae family (Order Asterales).

Description

The Dorrigo Daisy-bush is a single or multi-stemmed semi-herbaceous shrub. The bush grows 1–2.5 m high. It has alternate, crowded leaves attached to the stem. The leaves are linear, 20–90 mm long and 1–5 mm wide with a blunt but pointed tip. It is a short-lived shrub (four to five years), which produces a mass of white and yellow flowers from January to May.

The leaf margins are revolute and entire, and occasionally display a few small and scattered teeth. Surfaces are hairless with indistinct lateral venation. Inflorescences are terminal in simple corymbs ranging from 19–25 mm in diameter. Ray florets number 30–48, are white in colour and often tinged with violet. The yellow disc florets number 39–50. Achenes (fruit) are silky and the pappus has 36–50 bristles in one series. The peduncle reaches 52 mm long. (Lander n.d.; NSW Department of Environment and Conservation 2004; Gross & Mackay 2014).

Distribution

The Dorrigo Daisy-bush was presumed extinct not long after the initial collection in 1909, until rediscovery in 1984 (NSW Department of Environment and Conservation 2004). Currently, the Dorrigo Daisy-bush has a very restricted distribution; it exists as small subpopulations (of up to one thousand adults) across the northern fall of the Dorrigo Plateau in northern NSW (Mackay 2020). Total numbers of plants vary from year to year (Table 1) (NSW Department of Environment and Conservation 2004). To estimate fluctuation, the reported number of individuals was divided by the number of sites surveyed in an effort to account for the change in survey effort. Numbers of plants per site fluctuated, with as much as 219 percent variation between years (Table 1).

Table 1. Total counts and sampling effort of the Dorrigo Daisy-bush (NSW Department of Environment and Conservation 2004) with additional columns to highlight fluctuations in plants per effort of sampling and percent change from the previous sampling year.

Year	Number of plants (adults and seedlings)	Subpopulations	Sites surveyed	Count of plants per unit effort (number of sites surveyed	Percent change from previous survey period (increase or decrease in count per unit effort)
1989	850	24	26	33	
1991	800	13	29	28	–15
1994	1675	46	61	27	–0.5
1995	1237	33	59	21	–24
1997	2635	33	81	33	+55
1998	2086	36	84	25	–24
1999	1906	40	75	25	+2
2000	1576	37	57	28	+9
2001	989	46	83	12	–57
2002	721	38	88	8	–31
2003	2380	31	91	26	+219
2004*	3903	30	81	48	84
2005*	2781	33	82	34	-30
2014*	4446	15	79	56	+66
2016*	3758	13	66	57	+1
2018*	1569	12	70	22	-61
2020**	19 000+	13	80	238	+960

*data from (Mackay & Gross 2018) **data from (Mackay 2020)

Survey data demonstrate fluctuating populations (Table 1). Changes in the area of occupancy (AOO) and extent of occurrence (EOO) were also recorded in three years (Table 2).

Table 2. Area of occupancy (AOO) and extent of occurrence (EOO) for Dorrigo Daisy Bush (DPIE 2021)

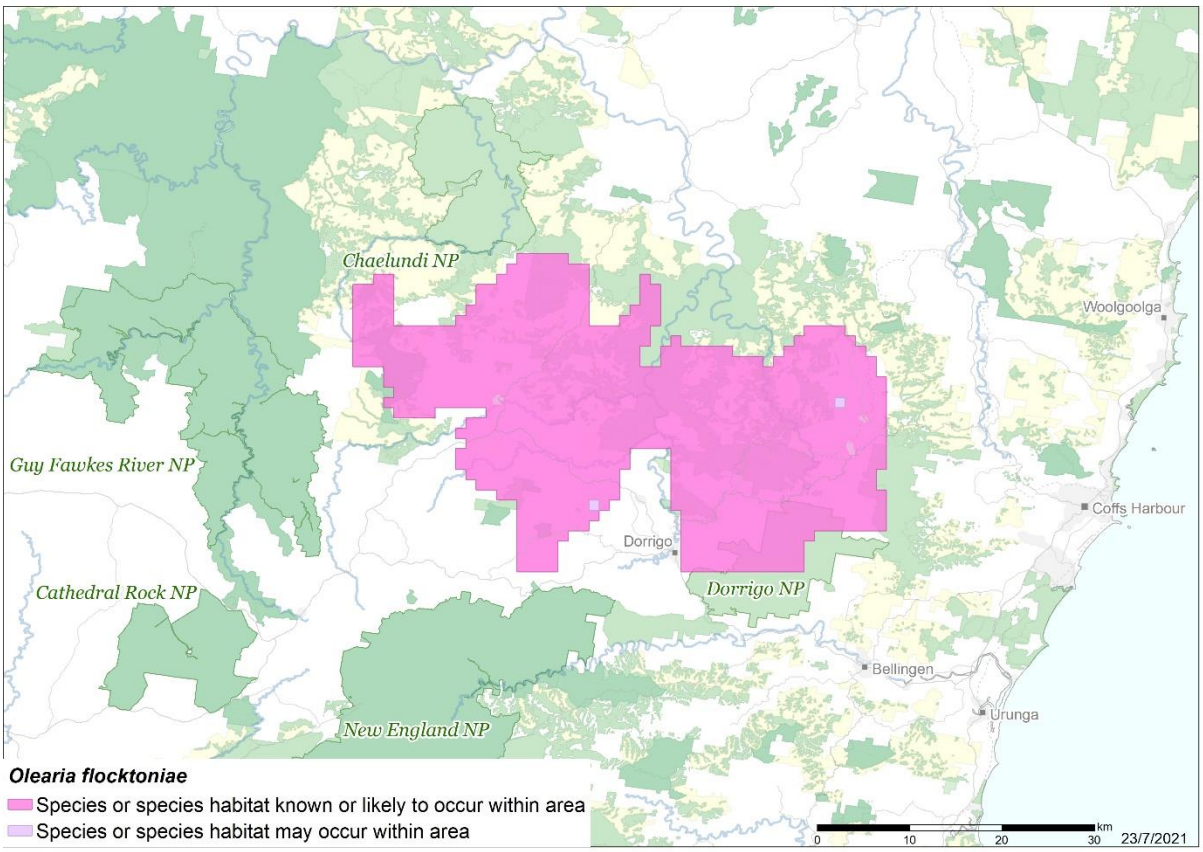
Year	AOO (km2)	EOO (km2)
2005	72	441
2014	40	452
2020	48	400

The majority of sightings are on the sedimentary rocks of the Brooklana, or older Moombil Beds on red and yellow podzolic soils (NSW Department of Environment and Conservation 2004). This species prefers disturbed areas and is mainly found at the edges of the forest, on road verges, timber plantations, quarries and transmission line easements adjacent to wet sclerophyll forest or rainforest. Previous habitat included the dynamic scree slopes of the eastern Great Dividing Range; however, heavy infestations of woody noxious weeds Lantana (*Lantana*

camara) and Small Leafed Privet (*Ligustrum sinense*) have stabilised slopes and inhibited the kinds of conditions required by pioneer species.

The Dorrigo Daisy-bush occurs in a mix of tenures, including parts of the Cascade National Park, Dorrigo National Park, Deer Vale Nature Reserve, Nymboi-Binderay National Park, as well as several state forest areas, including Wild Cattle Creek, Clouds Creek, Ellis and surrounding private lands. In 2018, 42 percent of the 1569 plants occurred on conservation reserves (Mackay & Gross 2018).

Map 1 Modelled distribution of Dorrigo Daisy-bush



Source: Species distribution data Species of National Environmental Significance database, Base map Geoscience Australia
Caveat: The information presented in this map has been provided by a range of groups and agencies. While every effort has been made to ensure accuracy and completeness, no guarantee is given, nor responsibility taken by the Commonwealth for errors or omissions, and the Commonwealth does not accept responsibility in respect of any information or advice given in relation to, or as a consequence of, anything containing herein.
Species distribution mapping: The species distribution mapping categories are indicative only and aim to capture (a) the specific habitat type or geographic feature that represents to recent observed locations of the species (known to occur) or preferred habitat occurring in close proximity to these locations (likely to occur); and (b) the broad environmental envelope or geographic region that encompasses all areas that could provide habitat for the species (may occur). These presence categories are created using an extensive database of species observations records, national and regional-scale environmental data, environmental modelling techniques and documented scientific research.

Cultural and community significance

Etymology: *Olearia flocktoniae* (Dorrigo Daisy-bush) was named after Margaret Flockton, a skilled and celebrated botanical artist employed by Joseph H. Maiden at the NSW botanical

gardens (Wilson 2016). There are no published ethnobotanical references related to this species, though the species occurs on Gumbaynggirr country.

Relevant biology and ecology

The Dorrigo Daisy-bush is a short-lived species, apparently with a short-lived seed bank (Gross & Mackay 2014). Lacking appropriate conditions, a subpopulation may die out within ten years. Due to these life-history traits, records older than ten years may not be reliable indicators of extant populations.

The Dorrigo Daisy-bush is an early recruit in newly disturbed areas, making it an important early successional (or pioneer) species (Gross & Mackay 2014). Seeds are short-lived in situ, persisting for four to five years in the soil after above-ground plants are dead. Seed viability reduces dramatically in situ (density of seedlings from soil cores were 140 m^2 at year zero to 25 m^2 in one year) (Gross & Mackay 2014). Survival rates from seedling to juvenile are around 44 percent and from juvenile to adult, approximately 50 percent (Gross & Mackay 2014; Mackay 2020).

Fluctuating populations

Populations of Dorrigo Daisy-bush fluctuate dramatically (see Table 1) with total count increases upwards of 900 percent and declines in some populations to zero, signalling a loss of above-ground plants. At least 68 of the 164 survey sites for Dorrigo Daisy-bush have disappeared between survey years 1989–2020, which was evidenced by the repeated zero counts of plants for four or more years (Mackay & Gross 2018). In 2020, 13 subpopulations remained, with a total of 19 000 plants, 16 000 of which were seedlings and more than 17 000 plants occurred in a single site which had held only 52 plants two years prior (Mackay 2020). The bush can reshoot from damaged stems and will reach 1 m in height after the first two years; it is reproductively mature in its second year. The bush may be capable of living longer, though observations indicate that, in the wild, the species does not live past four or five years (Gross & Mackay 2014). Over the course of 20 years, 27 subpopulations colonised and then died out. The number of colonists slightly increased the duration of the population ($R^2 = 0.22$). Disturbance had more of an influence ($R^2 = 0.83$) as it was found to concentrate the seeds resulting in a denser population that persisted longer (NSW Department of Environment and Conservation 2004; Gross & Mackay 2014). Between 1989 and 2020, surveyed subpopulations (number of plants per number of sites surveyed) were observed to fluctuate drastically between survey years (between 0.5 and 219 percent change on the previous year) (NSW Department of Environment and Conservation 2004; Mackay 2020). There was an observed shift in demography as adults declined and mass recruitment of seedlings was observed. However, no environmental variables were reported to explain the variation (NSW Department of Environment and Conservation 2004).

Reproduction

Some (but not all) individuals are self-compatible and self-pollinating. Flowers can emerge any time of the year; however, peak flowering occurs between December and May. The inflorescence is a capitulum of around 80 flowers, and in the first year, a plant may have up to six inflorescences, which can increase to up to 400 in older (four-year-old) plants. Between 80-100 seeds are produced from an inflorescence (NSW Department of Environment and Conservation 2004; Gross & Mackay 2014). The seeds have a fluffy pappus to assist with wind dispersal. Fresh

seeds, in glasshouse experiments, germinated within ten days, though viability varied from between 12 and 96 percent. Seeds remain in the soil and may germinate when ideal conditions allow. Seed banks lose viability over time and seed viability declines rapidly after four years. The key vulnerable times for the species are the transition into the seed bank and then to seedlings. Populations of established plants are transient, with a generation time of fewer than five years. Most plants in wild populations are outcompeted by shading from secondary forest recruits unless disturbance can initiate new recruits to germinate.

Disturbance

Standing plant subpopulations begin to decline if no disturbance has occurred within four to five years, and they will die out. Subpopulations originally recorded in areas that were gazetted National Parks were observed to disappear above ground, although the status of soil seed banks there is unknown (NSW Department of Environment and Conservation 2004). The disappearance of standing plants was attributed to the change in forest management practices and the lack of physical disturbance. Gross and Mackay (2014) noted that the standing population of Dorrigo Daisy-bush experienced a westward range shift of 35 km from the Great is required for In situ germination of the Dorrigo Daisy-bush is closely associated with disturbance. Seeds appear vulnerable to rotting due to soil humidity and temperature, and thus populations may require relatively frequent disturbance to persist *in situ* (Gross & Mackay 2014). Shallow (2–10 cm) manual disturbance of soil stimulates seedling emergence. Roadside disturbance typically occurs with heavy machinery during the grading of roads or the removal of weeds. Deep grading of the soils (beyond the B-horizon) did not result in the germination of Dorrigo Daisy-bush seeds, and so shallow soil disturbance (< 10 cm) is ideal (Gross & Mackay 2014). To date, the targeted, intentional disturbance trials have been very successful (Mackay 2020). In 2018–2019 experimental disturbance trials were conducted and the top 10 cm of soil was disturbed by bulldozing, which resulted in successful recruitment and was followed by the highest numbers of both adult and seedlings ever recorded (see Table 1; Mackay 2020).

Fire, and mechanical disturbance in association with pre and post-fire controls, may open up habitat for recruitment providing seedbanks are intact. The effect of fire on the viability of seeds is unknown. The footprint of the 2019-2020 bushfires overlapped with 36 percent of the modelled likely distribution of Dorrigo Daisy-bush (Department of Agriculture Water and the Environment 2020). Other types of disturbance (tree fall/erosion/rock or scree slides) would provide natural recruitment conditions; however, they are unlikely or too infrequent to sustain populations on the tracks and roadsides where the Dorrigo Daisy-bush is now distributed.

Genetic structure

Genetic studies on the Dorrigo Daisy-bush found moderate sub-structure among six subpopulations consistent with wind-dispersed species, though similarities in distant subpopulations were explained by movement of seeds by vehicles (Flood 2002). Patterns of genetic diversity suggested that repeat founding events had occurred in the past (most likely after the near extinction of the species sometime between 1909 and the early 1980s) (Flood 2002). An excess in heterozygotes was attributed to either reduced effective population size or selective processes and further investigation is needed. Seed banks of subpopulations that had since died above ground were not genetically different to extant subpopulations, highlighting that declines were caused by environmental and ecological events rather than lack of genetic

diversity. Flood (2002) concludes that the only way to overcome the final extinction for this species is by human intervention to ensure population expansion and ongoing survival.

Community
This species occurs adjacent to and on the edges of wet sclerophyll forest or rainforest. Dominant canopy species in association with the Dorrigo Daisy-bush are *Ceratopetalum apetalum* (Coachwood), *Doryphora sassafras* (Sassafras), *Eucalyptus microcorys* (Tallowwood), *Eucalyptus saligna* (Sydney Blue Gum), *Eucalyptus pilularis* (Blackbutt), *Eucalyptus acmenoides* (White Mahogany), *Lophostemon confertus* (Brush Box) and *Schizomeria ovata* (Crabapple). Other species found in association with the Dorrigo Daisy-bush include *Acacia binervata, Acacia melanoxylon* (Blackwood / Mudgerabah)*, Acacia longissimi* (Long-leaf wattle)*, Allocasuarina torulosa* (Forest Oak)*, Callicoma serratifolia* (Black Wattle)*, Cissus antarctica* (Kangaroo Vine)*, Cissus hypoglauca* (Water Vine), *Craspedia sp.* (Billy-buttons), *Duboisia myoporoides* (Corkwood), *Entolasia marginata* (Bordered Panic), *Eucalyptus grandis* (Flooded Gum), *Gahnia aspera* (Rough Saw-sedge), *Gonocarpus oreophilus, Coronidium rutidolepis, Microlaena stipoides* (Weeping Grass), *Ozothamnus diosmifolius* (Rice Flower), *Rubus moluccanus* (Molucca Bramble), and *Zieria southwellii*.

In 2020 Dorrigo Daisy-bush was surveyed from roadsides, easements, tracks and fire disturbed habitats and found in association with many of the above-mentioned species and also the following: *Anopterus macleayanus* (Queensland Laurel), *Dodonaea megazyga, Elaeocarpus reticulatus* (Ash Quandong), *Eragrostis sp.* (Lovegrass species undefined), *Hibbertia scandens* (Climbing Guinea Flower)*, Homalanthus populifolius* (Bleeding Heart), *Leptospermum polygalifolium* (Jellybush), *Pteridium esculentum* (Common Bracken)*, Solanum aviculare* (Kangaroo Apple)*,* and other regrowth within managed hardwood plantations and rainforest or eucalypt saplings on roadsides.

Dorrigo Daisy-bush was also found in association with introduced species: Cobblers Pegs (*Bidens Pilosa*), Flaxleaf Fleabane. (*Conyza bonarensis*), Ink Weed (*Phytolacca octandra*), Paspalum (*Paspalum dilatatum*), Wild Tobacco Bus (*Solanum mauritianum*) and the declared noxious weed, Giant Parramatta Grass *(Sporobolus indicus va. major)*.

Habitat critical to the survival

Due to the species eligibility for listing (highly restricted range), all habitat is considered critical to the survival of the species.

No Critical Habitat as defined under section 207A of the EPBC Act has been identified or included in the Register of Critical Habitat.

Important populations

In this section, the word population is used to refer to subpopulation, in keeping with the terminology used in the EPBC Act and state/territory environmental legislation.

There is sufficient evidence through the species eligibility for listing, to declare all populations/the national population of this species under particular pressure of survival and which therefore require protection to support the recovery of the species.

Threats

The Dorrigo Daisy-bush is exposed to different threatening processes depending on the life-history stage. Early life stages (seeds) are threatened by lack of soil disturbance required to initiate recruitment, while seedlings are threatened by uprooting, trampling, competition from grasses and other pioneer species. Adult life stages are threatened by disturbance, mechanical damage, chemical and fire exposure and pollination disturbance from feral bees. All threats are included in the table below and as many would be co-occurring, they should be considered cumulative with regard to their impact and management. Anecdotal evidence of lyre-birds digging up seedlings during foraging (Gross & Mackay 2014) and hypothesised seed predation (Office of Environment and Heritage 2017) are possible threats to Dorrigo Daisy-bush, though there are currently no data to detail the nature of the impact of these potential threats, and so they have not been included in Table 3.

Table 3. Threats impacting Dorrigo Daisy-bush

Threat	Status and severity [a]	Evidence
Climate change		
Altered fire regimes	Timing: current Confidence: estimated Consequence: major Trend: increasing Extent: across the entire range	Fire kills standing plants of Dorrigo Daisy-bush plants, and stimulates emergence of seedlings from soil-stored seedbanks (NSW Department of Environment and Conservation 2004). A high-frequency fire regime (< four years) is likely to reduce the population size of this species as it would not allow time for recruits to grow and release sufficient seed. Analysis by the Wildlife and Threatened Species Bushfire Recovery Expert Panel, based on intersecting the modelled distribution of the Dorrigo Daisy-bush and the National Indicative Aggregated Fire Extent Dataset, indicates that approximately 32% of the Dorrigo Daisy-bush range was within the extent of the 2019-2020 bushfire (Gallagher 2020). The species is patchily distributed throughout the modelled range and fire intensity was known to vary within the fire footprint (DPIE 2021). Fire suppression activities, fire disturbance and post-fire soil disturbance may have had positive impacts in some areas. Fire mitigation activities by the Royal Fire Service resulted in log removal and top soil disturbance which increased seed germination at some sites (Mackay 2020). Further field analysis is required to determine the overall impact of the recent bushfires (Wildlife and Threatened Species Bushfire Recovery Expert Panel 2020). Bushfires are predicted to increase in both frequency and intensity as a result of climate change and the species future response is uncertain.

Increased temperature intensity/frequency and change to precipitation patterns	Timing: current Confidence: projected Consequence: moderate Trend: increasing Extent: across the entire range	Climate projections for northern NSW predict increased temperatures as well as increased number of severe fire weather days in summer and spring (NSW 2014). Such changes in climate may cause widespread plant mortality in forest ecosystems, as many plants are vulnerable to drought stress and hydraulic failure (Allen et al. 2010; Choat et al. 2012). The Dorrigo escarpment influences local rainfall so that the majority of rain is deposited on the eastern fringe and decreasing with distance inland. Regional predictions of rainfall predict decreases in summer and winter rainfall, though increases in autumn and spring rainfall (NSW 2014). It's not known how changing rainfall patterns will impact extant Dorrigo Daisy-bush subpopulations (NSW Department of Environment and Conservation 2004).
Disturbance		
Lack of disturbance (seeds)	Timing: current Confidence: observed Consequence: major Trend: unknown Extent: across the entire range	Many *Olearia* species are pioneers, colonising unstable environments and disturbed niches (NSW Department of Environment and Conservation 2004). The Dorrigo Daisy-bush was observed to increase in number when clearings were first made for logging. This is typical of a pioneer species and first coloniser of heavily disturbed rainforest (NSW Department of Environment and Conservation 2004). Targeted disturbance of soil using a bulldozer adjacent to Dorrigo Daisy-bush subpopulations has resulted in a 92% increase in adult plants between survey years (Mackay 2020). A shift in land tenure may result in a lack of both disturbances required for germination and/or seed dispersal (e.g. cessation of road grading or timber harvesting or changing protocols that lower dispersal, such as cleaning of machinery on-site). Previous subpopulations, which were located in state forest tenures, disappeared completely when the areas were gazetted as a national park, thus changing disturbance regimes (NSW Department of Environment and Conservation 2004). Since then, the management of National Parks and Conservation areas have included disturbance as a management response to maintain populations of the Dorrigo Daisy-Bush (NSW Government 2016). Recent disturbance trials have shown that subpopulations at risk of dying out can be recovered using manual disturbance of the soils (with high success rates). The reliance on disturbance puts the species at risk should management priorities shift to protect species and habitats that are vulnerable to disturbance.

Inappropriately timed disturbance (adult plants)	Timing: current Confidence: observed Consequence: major Trend: unknown Extent: across part of its range	Juvenile plants are at risk of being uprooted by animals (e.g. birds) or damaged by vehicles or trampling (Gross & Mackay 2014). The ill-timed and inappropriate maintenance of roadside areas is a threat to the Dorrigo Daisy-bush. Pasture clearance, weed spraying, road grading and vegetation slashing can destroy adult plants and if this occurs prior to seed set, then the reproductive output of the population is impacted. There is a risk that the conservation management of Dorrigo Daisy-bush may be in direct conflict with the usual management of weeds and lack of disturbance required by other native vegetation (NSW Department of Environment and Conservation 2004).
Competition		
Invasion of grasses, particularly following fire or disturbance	Timing: current Confidence: inferred Consequence: moderate Trend: static Extent: across part of its range	Many introduced types of grass are characterised by vigorous growth, prolific seed production and effective seed dispersal. Accordingly, they can invade and establish in native vegetation, particularly following disturbance (D'Antonio & Vitousek 1992) Invasions of introduced grass species can affect ecosystems by altering system-level rates of resource supply (e.g. nitrogen-fixing grasses), as well as alter trophic structures, fuel loads and fire intensity and grazing disturbance patterns at ecosystem levels (D'Antonio & Vitousek 1992) Pioneer environments are quickly colonised by grasses and shrub species, potentially preventing the emergence of Dorrigo Daisy-bush seedlings (Gross et al. 1998). The invasion of native plant communities by exotic perennial grasses was listed as a key threatening process (KTP) under the Threatened Species Conservation Act in NSW (NSW Scientific Committee 2003).
Outcompeted by native secondary recruiters	Timing: current Confidence: observed Consequence: minor Trend: unknown Extent: across the entire range	In glasshouse experiments, Dorrigo Daisy-bush was a successful competitor to native grass species (*Microlaena stipoides*) when simultaneously germinating; but had significantly reduced germination in the presence of an established grass mat (or when seeds were sown greater than 5-10 cm deep) Gross et al. 1998). Adult Dorrigo Daisy-bush are rapidly outcompeted by other pioneer shrubs and vines, and the establishment of these competitor species has resulted in past rapid declines of Dorrigo Daisy-bush (NSW Department of Environment and Conservation 2004).
Pollination disruption		

Pollination disruption by European honeybee (*Apis mellifera*)	Timing: current Confidence: suspected Consequence: minor Trend: unknown Extent: unknown	In pioneer environments, honeybees can perturb native plant-bee relationships and reduce plant fitness (Gross and Mackay 1998). Feral honeybees feature as a key threat in the Northern Rivers Regional Biodiversity Management Plan Department of Environment Climate Change and Water NSW 2010). The Plan highlights that research is required to determine if feral Honeybees are affecting pollination rates in the Dorrigo Daisy-bush (Department of Environment Climate Change and Water NSW 2010). As the Dorrigo Daisy-bush is capable of self-pollination, it's unclear how severe pollination disturbance is to this particular species. Further, the Regional Pest Management Strategy states that although feral honeybees have not been mapped, they are more abundant in urban and coastal reserves than in rural and inland areas (Office of Environment and Heritage 2012).
Fragmentation		
Loss of genetic diversity	Timing: future Confidence: suspected Consequence: moderate Trend: unknown Extent: across the entire range	A loss in genetic diversity can result in a loss of overall fitness for the species and a declined ability to respond to changing environmental conditions. The genetic diversity of the Dorrigo Daisy-bush was investigated, and an excess of heterozygotes was observed. This could be caused by several processes, including loss of effective population size, evolutionary selection processes. There was no strong evidence of inbreeding in the population. There was concern that the ongoing loss of subpopulations would result in a reduction of genetic diversity. Flood (2002) recommended an ongoing genetic census as part of the management plan. During molecular research on the Dorrigo Daisy-bush, there was some question about the diploid nature of the species (pers comm. Caroline Gross 2020) and polyploidy should be investigated to clarify past and future genetic investigations.

Status—identify the temporal nature of the threat;

Confidence—identify the extent to which we have confidence about the impact of the threat on the species;

Consequence—identify the severity of the threat;

Trend—identify the extent to which it will continue to operate on the species;

Extent—identify its spatial content in terms of the range of the species.

Each threat has been described in Table 3 in terms of the extent that it is operating on the species. The risk matrix (Table 4) provides a visual depiction of the level of risk being imposed by a threat and supports the prioritisation of subsequent management and conservation actions. In preparing a risk matrix, several factors have been taken into consideration, and they are: the life stage they affect, the duration of the impact, and the efficacy of current management regimes, assuming that management will continue to be applied appropriately. The risk matrix and ranking of threats has been developed based on consultation with experts and using available literature.

Table 4 Dorrigo Daisy-bush risk matrix

Likelihood	Consequences				
	Not significant	Minor	Moderate	Major	Catastrophic
Almost certain	Low risk	Moderate risk	Very high risk	Very high risk	Very high risk
Likely	Low risk	Moderate risk **Outcompeted by native secondary recruiters**	High risk **Increased temperature intensity/frequency and change to precipitation patterns**	Very high risk **Altered fire regime** **Lack of disturbance (seeds)** **Inappropriately timed disturbance (adults)**	Very high risk
Possible	Low risk	Moderate risk	High risk **Invasion of grasses, particularly following fire or disturbance**	Very high risk	Very high risk
Unlikely	Low risk	Low risk	Moderate risk	High risk	Very high risk
Unknown	Low risk	Low risk **Pollination disruption by European honeybee (*Apis mellifera*)**	Moderate risk **Loss of genetic diversity**	High risk	Very high risk

Priority actions have then been developed to manage the threat, particularly where the risk was deemed to be 'very high' or 'high'. For those threats with an unknown or low-risk outcome, it may be more appropriate to identify further research or maintain a watching brief.

Conservation and recovery actions

Primary conservation objective

By 2030, viable populations of Dorrigo Daisy-bush are maintained in habitats where disturbance requirements are met to ensure ongoing recruitment.

Conservation and management priorities

The Dorrigo Daisy-bush has been listed as a target species for post-fire assessment and monitoring in a project managed by the University of New England titled: Assessing, monitoring and enhancing priority plant species recovery after a fire (Department of Agriculture Water and the Environment 2020).

Seed collecting, propagation and reintroductions are aims of the project: 'Banking on seeds for bushfire recovery-insuring against future loss' managed by the Council of Heads of Australian Botanic Gardens Incorporated (trading as Australian Seed Bank Partnership)(Department of Agriculture Water and the Environment 2020).

The long-term management target by DPIE is to have a minimum of ten subpopulations subject to ongoing disturbance management (DPIE 2021). Seven extant subpopulations have already been identified for management (Office of Environment and Heritage 2017). The 2018-2019 experimental disturbance trials were very successful and they resulted in high levels of recruitment (Mackay 2020).

Habitat loss, disturbance and modifications

- Develop and implement an appropriate management strategy for sites (including protected areas) where the Dorrigo Daisy-bush is found that facilitates suitable disturbance activities to maintain long-term population persistence.
- Maintain existing registers of all disturbance activities adjacent to adult Dorrigo Daisy-bush and monitor biological responses to disturbance.
- Avoid disturbing living Dorrigo Daisy-bush plants, particularly before fruit-set.
- Ensure local governments, relevant state agencies and utility service providers have access to adequate information regarding the location of the Dorrigo Daisy-bush and use best practice methods for roadside and utility corridor maintenance to protect the Dorrigo Daisy-bush and provide a suitable disturbance regime.
- Ensure that property, forest edge, and roadside maintenance (slashing, burning, spraying, grading) does not occur in areas where populations of Dorrigo Daisy-bush are in peak flowering and seed set times.
- Educate road site maintenance staff in the identification and management of the Dorrigo Daisy-bush and/or mark sites where the bush occurs so that roadside maintenance staff apply appropriate protocols. Roadside marking should occur with annual surveys.
- Review roadside maintenance protocol in light of current and emerging research on how the species responds to in-situ management (slashing, selective removal of competitors, soil disturbance, selective herbicide application). Update the roadside maintenance protocol (NSW Department of Environment and Conservation 2004) and communicate, coordinate, distribute and implement the protocol on all relevant tenures.

Invasive species (including threats from grazing, trampling)

- Manage invasive weeds at Dorrigo Daisy-bush sites with appropriate methods, taking into account proximity and life stage of Dorrigo Daisy-bush plants, particularly during critical reproductive (flowering and seed set) periods.
- Use non-chemical methods of weed removal in areas proximal to adult and juvenile Dorrigo Daisy-bush.
- Provide Dorrigo Daisy-bush identification guides to all stakeholders involved in roadside, pasture and forest edge weed control on all tenures.

Fire

- Fires must be managed to ensure that prevailing fire regimes do not disrupt the life-cycle of the Dorrigo Daisy-bush, particularly during peak flowering and seed set. Ensure fires support rather than degrade the habitat necessary to the species, that they do not promote invasion of exotic species, and that they do not increase impacts of grazing/predation.

- Survey known populations and also areas where fire mitigation (and soil disturbance) activities have occurred to determine the conditions where fire has had a positive or negative impact and also where post-disturbance recruitment has occurred.
- Develop and implement a fire management strategy that optimises the survival of the Dorrigo Daisy-bush (and potentially other regional threatened plant species), and which also integrates and implements the post-bushfire management responses identified for priority threatened plants exposed to cumulative risks (Wildlife and Threatened Species Bushfire Recovery Expert Panel 2020). These actions include:
  - Ongoing field inspections – seedling emergence assessment
  - Post fire weed control
  - Exclude prescribed fire
  - Rapid response to wildfire
- Fire management authorities and land management agencies should use suitable maps and install field markers to avoid damage to the threatened species

Breeding, seed collection, propagation and other ex situ recovery action

- Collate data from previous ex-situ propagation and cultivation trials and consider future trials of in-situ/inter-situ and ex-situ propagation and cultivation.
- Evaluate the risk of losing genetic diversity, and if appropriate, undertake appropriate seed and storage in long term custodial collections until no longer needed and determine the viability of stored seeds. Best practice seed storage guidelines and procedures should be adhered to maximise seed viability and germinability. Seeds from all-natural populations to be collected and stored.
- Propagate sufficient individuals to augment extant populations and if feasible, undertake translocations, according to Commander et al. (2018).
- If augmentation is required re-introduce ex-situ material (seeds / seedlings) into existing site(s). Continue maintenance of the population until it is self-sustaining (i.e., producing fertile offspring).

Stakeholder engagement/community engagement

- Engage relevant stakeholders and land managers from Forestry Corporation of NSW, National Parks and Wildlife Service, industry, First Nations groups and private landholders for coordination of recovery actions.
- Engage and involve Traditional wners in conservation actions, including the implementation of Indigenous fire management and other survey, monitoring and management actions.
- Liaise with the local community and government agencies to ensure that up-to-date population data and scientific knowledge inform the implementation of conservation actions for this species.
- Contribute to impact assessment and planning processes on measures to protect the Dorrigo Daisy-bush and its habitat.

Survey and monitoring priorities

- Continue to locate and monitor new and existing populations of Dorrigo Daisy-bush and key biological parameters in response to environmental and management predictor variables (particularly mechanical and fire disturbance).
- Monitor the size (and age) structure and reproductive status of subpopulations at different stages in response to disturbance, taking opportunities to monitor after planned and unplanned disturbance events (where they occur) and improve understanding of the disturbance response of the species.
- Monitor the trajectory of subpopulations, including the effectiveness of management actions (particularly recruitment response to mechanical disturbance) and the need to adapt them if necessary.
- Develop habitat suitability models to determine the ecological/environmental indices responsible for species distribution and how it may change due to the impending threats (Guisan & Zimmermann 2000).

Information and research priorities

- Integrate findings from recovery projects into management for the Dorrigo Daisy-bush. Include results from post-2019-2020 bushfire projects:
  - Assessing, monitoring and enhancing priority plant species recovery after fire. The University of New England. Dorrigo Daisy-bush is one of the 19 plants identified for monitoring and enhancement of recovery activities in this project.
  - Banking on seeds for bushfire recovery. Insuring against future loss. Council of Heads of Australian Botanic Gardens Incorporated (trading as Australian Seed Bank Partnership). Dorrigo Daisy-bush is one of 25 plants identified for seed collection, germination and propagation trials, reintroduction and long-term ex situ banking of seed in this project.
- Undertake or integrate existing post-fire monitoring to understand the response of Dorrigo Daisy-bush (adults and seed bank) to different fire regimes. Integrate knowledge into fire management regimes on all tenures.
- Undertake in-situ research to better understand competition, disturbance and succession of the Dorrigo Daisy-bush to determine thresholds to recruitment, life span and reproductive success.
- Undertake seed germination and seed burial experiments to improve understanding of seed dormancy mechanisms and seed bank decay rates.
- Determine the chromosome state of Dorrigo Daisy-bush (diploid/polyploid) and undertake molecular studies appropriate to the state to resolve the levels of gene flow and genetic diversity of subpopulations.
- Determine if pollinator competition occurs between native pollinators of Dorrigo Daisy-bush and invasive species (particularly feral bees or the European wasp).

Links to relevant implementation documents

Dorrigo Plateau Group of Nature Reserves Plan of Management (2008)

Draft recovery plan for *Olearia flocktoniae* (Dorrigo Daisy-bush) (2004)

Northern Rivers Regional Biodiversity Management Plan, National Recovery Plan for the Northern Rivers Region (2010)

NSW Saving our Species Strategy – Dorrigo area management with actions specific to Dorrigo Daisy-bush.

2019-2020 Bushfires Recovery Planning. Rainforests of the NSW north coast and tablelands (2020)

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