Conservation Assessment of *Pittosporum kororoense* Benwell (Pittosporaceae)

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NSW Threatened Species Scientific Committee

Pittosporum kororoense Benwell (Pittosporaceae)

Distribution: Endemic to NSW.
Current EPBC Act Status: Not listed.
Current NSW BC Act Status: Critically Endangered.
The species was provisionally listed on an emergency basis on the 21st February 2022 under the previous name of *Pittosporum* sp. Coffs Harbour (A.S.Benwell 342, NSW1102028).

Proposed listing on NSW BC Act: Critically Endangered.

Proposed listing on EPBC Act: Critically Endangered

Summary of Conservation Assessment

Pittosporum kororoense Benwell was found to be eligible for listing as Critically Endangered under IUCN Red List Criteria B1ab(iii,iv,v)+2ab(iii,iv,v) and C1+2a(ii). The main reasons for this species being eligible are: i) it has a very highly restricted geographic range, ii) it is severely fragmented, iii) it has a very low number of mature individuals, (iv) there is observed and inferred continuing decline and v) all mature individuals of the species occur within one population.

Description and Taxonomy

Pittosporum kororoense Benwell is a recently described species from the New South Wales mid-north coast. *Pittosporum kororoense* Benwell has previously been referred to as '*Pittosporum* sp. Coffs Harbour (A.S.Benwell 342, NSW1102028)'. *Pittosporum kororoense* is distinct from other known *Pittosporum* species (Makinson *in litt.* October 2021; Cayzer *in litt.* November 2021; Benwell 2023). A genomic study has also supported *P. kororoense* Benwell as a new species (ReCER 2021). *Pittosporum kororoense* Benwell is described as a "shrub to 1.2 m high, single-stemmed, rhizomatous, often growing in dense, clonal patches 1–4 metres diameter, sometimes in small aggregations (<10 stems), rarely as a lone stem; stems arising from horizontal roots. Stems with grey-brown bark, knobbly with many petiole/branchlet scars and short, smooth sections; branching verticillate, bi- or trifurcate, ascending; twiglets brown, glabrous, vertically ridged, lenticellate, cataphylls ± persisting at ultimate nodes; shoots non-spinescent. Indumentum of white T-hairs only, very sparse on leaves, denser on pedicles, otherwise plant glabrous. Leaves alternate but becoming whorled/congested/verticillate (through shortening of internode distances) at terminal nodes; oblanceolate to almost obovate and elliptical, up to 85–112 mm long, 22–30 mm wide, petiole up to 5–8 mm; apex acute, finely mucronate, hooked; base almost subsessile, winged to a thick triangular base; adaxial surface smooth, secondary veins slightly impressed, mid-vein in slightly raised groove; abaxial surface much paler, smooth, 7–8 pairs secondary veins, very slightly raised, tertiary venation not visible when fresh, becoming more pronounced on drying on both surfaces, reticulum faint but distinct; scattered white T-shaped hairs only; margins when fresh are flat with the

apices slightly down turning, spines absent. Inflorescences aggregated in ultimate leaf whorls; each terminal on a slender shoot up to 10 mm long, arising from a basal involucre 1–2 mm long and wide; 1–3 single flowers, each flower subtended by a leaf; indeterminate growth (becomes axillary as shoot develops next season); pilose with T-shaped hairs: short base, longer arm, white; flower buds bullet-shaped; pedicels pilose to 3 mm long; flowers actinomorphic, unisexual, functionally male with vestigial pistil, corolla hypocrateriform/salverform, persisting slightly tubular with the petal apices reflexing; sepals to 5 mm long, very narrow, linear/acuminate, appressed, sparsely hairy on outer surface, not recurving and not caducous; petals 10–11 mm long, 3 mm wide, initially creamy yellow becoming slightly darker yellow with age. *Male flowers*, only male flowers seen. *Stamens* 6–8 mm long. *Anthers* nearly 2 mm long, slender rectangular, apices recurving backwards revealing slits and pollen; filaments adnate to petal, joined at anthesis; pistil to 7 mm long, ovary barely differentiated, 2 mm long, on a 2 mm stipe from the basal nectary. *Style* 4 mm long with little stigmatic development. *Fruit* a sub-globose capsule held upright, 8–12 mm long, 10 mm diam, plus a 2 mm long basal, lobed nectary, dehiscence loculicidal, 4-grooved, 2-valved, pedicel elongating to 7 mm as fruit ripens; exocarp yellow, glabrous, rugulose, on a 2 mm thick, erect stalk; valves bright, glossy yellow on inside surface; fruit very rare. *Ovary* funicles inserted basally in 2 loculi; seeds 2–6 per fruit, angular to reniform, fresh seed to 5 mm long with succulent, red outer layer, sticky/resinous; valves open to 90° and held flat to present red seeds, then after seeds are taken or fall, reflexed 180° to touch pedicel and curl up." (Benwell 2023).

Two other species of *Pittosporum* (*P. undulatum* and *P. revolutum*) grow in the same general area as *P. kororoense*. Another related *Pittosporum* species (*P. lancifolium*) occurs on the far north coast near Lismore. The main features that distinguish *P. kororoense* from these three other *Pittosporum* species include: its habit as a low erect shrub producing prolific ramets from rhizomes (cf. tall shrub to sizeable trees in *P. undulatum* and *P. lancifolium*; or shrub or small tree 1–4 m tall for *P. revolutum*); inflorescences 1–3-flowered, unbranched (cf. 6–35-flowered and very often branched (compound umbels) in *P. undulatum*; cf. 4–16?-flowered in *P. revolutum*, sometimes branched (compound); cf. 1– or rarely 2–flowered and unbranched/non-compound in *P. lancifolium)*; fruit dull orange at maturity (cf. black in *P. lancifolium*), and containing only two(-6) seeds (cf. 12–14 in *P. lancifolium*; 'numerous' in *P. undulatum*; 20–78 in *P. revolutum*); and a lack of foliar aromaticity and floral fragrance (Makinson *in litt.* October 2021). Benwell (2023) provides a comparison of morphological attributes of *Pittosporum* species that occur from Coffs Harbour to NSW/Queensland border as well as a key to *Pittosporum* species in NSW.

In this assessment, the word population is used to refer to the concept of 'subpopulation' in IUCN (2022), in keeping with the terminology used in the NSW BC Act, Commonwealth EPBC Act and other state/territory environmental legislation and general biological usage. For *Pittosporum kororoense*, the only known population has been fragmented by clearing, so the various areas of current occurrence of the species will be referred to as 'sites' in this assessment.

Distribution

Pittosporum kororoense is endemic to New South Wales and is currently known to occur in a small area near Coffs Harbour on the New South Wales mid-north coast. The species is currently known from one population scattered across eight sites associated with wet sclerophyll-rainforest in sheltered areas, including lower, south-facing slopes, along drainage lines and in gullies, generally within 5 km of the ocean (Anon. *in litt.* October 2021). The sites are at low elevations apart from the western-most site at 200m elevation in the headwaters of a creek. Much of the area between the sites is cleared (Appendix 2). Anon. (*in litt.* October 2021) notes "The species appears to have already had a highly restricted geographic distribution at the time of settlement, as indicated by the distribution of known localities and their association with the eastern end of the coastal range, which may have acted as a topographic and microclimatic refugia for the species, and by the species absence from areas surveyed further away." However, *P. kororoense* may not be limited to these topographies or to the Coffs Harbour area.

Since the species first came to scientific attention in January 2021, there have been three targeted surveys for *Pittosporum kororoense*. These surveys were undertaken for Transport for NSW (TfNSW) given that part of the population of *P. kororoense* will be affected by approved roadworks in the area. The surveys were carried out near the original site and up to 15 km away, in the same type of habitat (i.e., topography and broad vegetation type – primary or secondary (altered) forest).

The geographic distribution of *Pittosporum kororoense* is very highly restricted. The area of occupancy (AOO) and the extent of occurrence (EOO) were estimated using the GeoCAT tool (Bachman *et al.* 2011) with the adjustment of the grid reference point to give the minimum AOO estimate as per NSW TSSC Guidelines (2020) and IUCN (2022). Occurrence data were available from Ecos Environmental (2022). The AOO was estimated to be 8 km^2 based on the species occupying two (2 km x 2 km) grid cells, the spatial scale of assessment recommended by IUCN (2022). The EOO was estimated to be 3.2 km^2 based on a minimum convex polygon enclosing all reliably mapped occurrences of the species, the method of assessment recommended by IUCN (2022). However, the EOO was adjusted to equal to the AOO (i.e., 8 km^2), as IUCN (2022) note that "If EOO is less than AOO, EOO should be changed to make it equal to AOO to ensure consistency with the definition of AOO as an area within EOO."

The recent formal description of *Pittosporum kororoense* mentions the sighting of a possible second population of the species 50 km south of Coffs Harbour (Benwell 2023). More information is needed on this recent sighting and it has not been included in this assessment.

Ecology

Pittosporum kororoense is currently known (Benwell 2023) to occur in forest 30-40 m high and dominated by *Lophostemon confertus* (Brush Box), with *Eucalyptus grandis* (Flooded Gum), *E. microcorys* (Tallowwood) and *E. pilularis* (Blackbutt) subdominant. The forest mid-stratum consists of rainforest trees 5-20 m high, including *Dysoxylum mollissimum* (Red Bean), *Cryptocarya microneura* (Murrogun), *Cryptocarya rigida* (Forest Maple), *Elaeocarpus reticulatus* (Blue-berry Ash), *Endiandra discolor* (Domatia Tree), *Synoum glanduluosum* (Scentless Rosewood), *Niemeyera whitei* (Rusty Plum), *Archontophoenix cunninghamiana* (Bangalow Palm), *Ficus watkinsiana*

(Strangler Fig) and other tree species, as well as shrubs, vines, herbs and ground ferns. Exotic species such as *Hypoestes phyllostachya* (Polka-dot-plant) may be present. The soil is a red-yellow clay podzol formed on metasediment. A few plants of *P. kororoense* extend to the mid slope into *Eucalyptus* spp. dominated forest (*E. microcorys, E. grandis, E. saligna, E. acmenoides*) (Benwell 2023). *P. kororoense* may occur in other topographies, vegetation communities and edaphic conditions.

Brush Box – rainforest and stands of subtropical rainforest are rare in the Coffs Harbour area, which is mostly dominated by eucalypt forest. This habitat, mostly at low elevation, shows evidence of low to moderate intensity logging in the past and was probably grazed by cattle (Ecos Environmental 2022). "Generally, the floristic composition and vegetation structure of secondary regrowth patches is simplified and the ground layer of native ferns, herbs and sedges often missing, indicating almost total clearing in the past, followed by recolonisation by a reduced pool of more resilient native species as cattle and dairy grazing, in particular, waned in the last 50 years." (Anon. *in litt.* October 2021). The largest remaining area of relatively undisturbed Brush Box – rainforest in the Kororo area will be affected by roadworks for the Coffs Harbour bypass project (hereafter referred to as the roadworks project). The largest concentration of *Pittosporum kororoense* is located in the rainforest remnant with the majority of plants inside the roadworks project boundary (Ecos Environmental 2022).

Pittosporum kororoense is a clonal species (ReCER 2021, 2022), based on the growth form comprising multiple stems (or ramets - genetically identical stems) emerging from the ground and linked by an underground root system forming a mature individual (or genet) (Anon. *in litt.* October 2021; Benwell 2023). This is an unusual growth form among its congeners. The stems generally grow 0.5-1 m high, with a maximum height of 1.3 m and form a low thicket. Stems grow from horizontal roots about 10 cm below ground. Patches of *P. kororoense* vary in size from <2 to 15 m^2 or more and have a few to over 500 individual stems. Some patches are very small, consisting of <10 stems, and a few occurrences are single stems. Further study and monitoring are required to ascertain the life cycle or longevity of stems forming the clonal patches, however initial observations indicate newly emerged stems are slow growing and long-lived (probably live for 20 years or more (Anon. *in litt.* October 2021)). Young stems can be seen sprouting up around the edge of patches indicating the patches can expand vegetatively.

Pittosporum kororoense has low fecundity typical of many clonal plants (e.g. *Haloragodendron lucasii* (Sydes and Peakall 1998), *Acacia meiantha* (Tindale *et al.* 1992)) and effective sexual reproduction may be limited in the species. Flowers were common, but not prolific on *P. kororoense* plants. Red fleshy seeds are displayed in opened fruits against a bright yellow background formed by the inside surface of the open fruit valves, indicating the species may be dispersed by birds. The few seeds in these open fruits appeared to be viable (i.e., filled out). Observations from monthly visits to the largest site of *P. kororoense* (which are affected by roadworks) between January and July 2021 showed seed production was very low, with a total of only 15 fruits recorded. Fruit production was surveyed again in December 2021 in patches inside and outside the roadworks project boundary. Fruit production was again low and only seen on plants inside the roadworks project boundary, though not within the roadworks footprint (Ecos Environmental 2022). The site that will be impacted by the roadworks project was the only site where fruits/seeds have been found (Ecos Environmental 2022).

Abundance

A genetic study of *Pittosporum kororoense* confirmed that the species is clonal with high levels of inbreeding (ReCER 2021). Estimating the number of mature individuals in clonal species requires interpretation of what constitutes an independent reproductive unit (*sensu* IUCN 2022). The separate stems (ramets) within the patches of *P. kororoense* are not known to survive independently as they are linked by underground roots. If the patches comprise a central root system from which all other roots radiate, the death of the centre of the patch may result in the death of the patch as a whole, suggesting each patch represents a mature individual. This had been observed in other clonal species. For example, *Acacia carneorum* is a highly clonal species (Roberts *et al.* 2017) that occurs on sand dunes as multiple large trunks connected by a root system. When individual trunks die, there is ongoing mortality of trunks along the length of the dune (Auld *et al*. 2015). In such cases, the clonal patches on a dune likely represent a single mature individual (*sensu* IUCN 2022).

The genetic study (ReCER 2022) showed that distinct patches of *P. kororoense* generally represent distinct genetic individuals (genets), although some patches may contain more than one genet, or one genet may include several patches. ReCER (2022) analysed 10 patches (these were subsequently cleared for roadworks) and found that they comprised 17 unique genets.

The best estimate for the number of mature individuals of *Pittosporum kororoense* was 57-97. This is based on the number of patches of *P. kororoense* (determined by Ecos Environmental, 2022) and the results of the genetics study (ReCER 2021). The current number of patches of *P. kororoense* plants (57) is the lower bound estimate for the number of mature individuals, with the upper bound estimate of 97 representing the number of genets (assuming a ratio of patches to genets on average of 1 patch representing 1.7 unique genets, based on sampling in ReCER (2022)).

Threats

The main threats to *Pittosporum kororoense* are from land clearing and ongoing habitat degradation from roadworks for the Coffs Harbour bypass project, agricultural activities, urban development, weed invasion, recreational impacts, and rubbish dumping. Two of the eight known sites are protected from clearing as one is in a Nature Reserve and the other one is within a Flora Reserve within a State Forest. All other sites are on private land or land owned by TfNSW.

<u>Clearing – past and current.</u>

Much of the likely habitat for *Pittosporum kororoense* has been cleared in the past for grazing by domestic stock, timber collection, food production, such as bananas, and more recently for urban development and blueberry farms. It is estimated (from survey observations by Anon. (*in litt.* October 2021)) that more than 80% of the original lowland wet sclerophyll forest in the Coffs Harbour and Kororo Basins has been cleared, and *P. kororoense* may have suffered a similar reduction in total population size.

The current habitat of *P. kororoense* comprises small vegetation remnants surrounded by largely cleared areas. Much of the remnant habitat is secondary regrowth with scattered, relic mature trees and small pockets of undisturbed understorey vegetation (Ecos Environmental 2022). The largest and relatively undisturbed Brush Box – rainforest containing *P. kororoense* in the Korora area will be impacted by the

roadworks project. There are eight sites currently known that contain *P*. *kororoense,* with sites 1 and 2 within the roadworks project boundary.

Some *Pittosporum kororoense* individuals and their habitat have been cleared for the roadworks project. Thirty-three percent of the estimated number of mature individuals of the species are within the roadworks project boundary, with 15% recently cleared and 18% likely to be impacted by the roadworks. The *P. kororoense* plants to be impacted by the roadworks are within the largest site and contain the largest patches (both in terms of spatial area/spread and number of individual stems). Of the total number of known stems of the species, it is estimated 62% will be affected by the roadworks, with 30% recently removed and a further 32% affected due their proximity to the roadworks (Ecos Environmental 2022).

The *Pittosporum kororoense* plants that were cleared have been translocated to sites nearby (TfNSW 2022). Of the four translocation sites, three are on land directly adjacent to the roadworks project boundary and one is within the roadworks project boundary. Three of the four are on land owned by TfNSW, and one is in a Nature Reserve (TfNSW 2022). For inclusion in an assessment under IUCN (2012), a translocated population is only considered viable when the translocated plants have established and are self-sustaining, (i.e. when the plants have produced viable offspring that have reached maturity or are likely to do so) and at least five years have passed since the introduction (IUCN 2022). Consequently, any translocation of *P*. *kororoense* plants cannot be considered as a part of the mature population for this assessment. Plants of *P. kororoense* occurring in the roadworks project boundary that have not been cleared will be retained *in-situ* and a management plan has been developed (TfNSW 2022), although some surrounding habitat will be cleared at this site. See 'Habitat loss and disturbance' (below) for impacts of the roadworks project on this site.

Habitat loss and degradation from roadworks

The largest number of *Pittosporum kororoense* plants are located within or close by to the boundary of the roadworks project. Some of the existing vegetation within the project boundary has been cleared, including *P. kororoense* plants, reducing the size of the remnant vegetation and increasing edge effects. Part of the area containing *P. kororoense* within the roadworks project boundary will be retained but remaining plants will be in close proximity to cleared areas and road construction activities with associated risks to remaining plants and their habitat (TfNSW 2022). A management plan to minimise the potential impacts to the retained *P. kororoense* plants has been developed (TfNSW 2022). TfNSW (2022) have outlined a number of impacts to *P. kororoense* plants and habitat due to the roadworks. Clearing of the adjacent vegetation may lead to changes in the micro-climatic conditions of the site (TfNSW 2022). Micro-climatic stress during dry periods may reduce the ability of seedlings and juvenile plants to survive and establish. The edges of remnant bush that are exposed are also at an increased risk of weed invasion reducing the suitability of the habitat. Pest fauna movement may increase due to the introduction of cleared areas adjacent to the highway and may lead to increased grazing on individual threatened plants and/or predation of seeds as well as introducing/spreading pathogens and disease (TfNSW 2022). The increased accumulation of dust on the photosynthesising leaf surfaces of individual plants has the potential to cause individual plant stress and/or mortality (TfNSW 2022). These changes will likely lead to reduced plant health,

reduced reproduction and/or individual plant survival and reduced establishment and survival of seedlings and juvenile plants of *P. kororoense*.

Other sites outside the roadworks project boundary that are also adjacent to cleared land are subject to edge effects, including changes in micro-climatic conditions, increased prevalence of weeds, disturbance from grazing by feral and domestic animals, and the possibility of further clearing on private land.

Agricultural activities

Most sites are surrounded by privately owned cleared land used for agricultural activities including blueberry farming. Agricultural activities such as slashing, track-making, drainage works and runoff from pesticide and other agricultural chemical usage etc. can lead to edge effects and loss and degradation of habitat of *P. kororoense.*

Urban encroachment

Habitat degradation and loss was observed at the largest site due to recreational use and rubbish dumping. There is a trail bike track next to patches of *Pittosporum kororoense* and through its habitat, and rubbish dumping is occurring in the forest near existing patches of *P. kororoense*.

Weed encroachment

Exotic plant species have invaded some habitat areas, notably at the largest site (that is impacted by roadworks) where *Cinnamomum camphora* (Camphor Laurel) and *Hypoestes phyllostachya* (Polka-dot Plant) occur. In some areas of this site the weeds are dense (TfNSW 2022). Weed species compete with *Pittosporum kororoense* for habitat, may change micro-habitat conditions, and impede recruitment of *P. kororoense* resprouts or seedlings and other native species.

Browsing by feral animals and domestic stock

Feral deer and horses are present in the area where *Pittosporum kororoense* occurs (TfNSW 2022). While there is no evidence or observations that feral deer have been damaging *P. kororoense* plants, they may kill or damage seedlings and saplings of other habitat species by their browsing activities, which in some cases includes stripping bark from trunks, reducing plant vigour, promoting disease entry, or even ring-barking stems.

Site visitation

Visitation, both authorised and unauthorised, could lead to disturbance of *Pittosporum kororoense* and its habitat and may introduce pathogens such as *Phytophthora* species to the habitat. 'Infection of native plants by *Phytophthora cinnamomi'* is listed as a Key Threatening Process under the Act.

Assessment against IUCN Red List criteria

For this assessment it is considered that the survey efforts for *Pittosporum kororoense* have been adequate and there is sufficient scientific evidence to support the listing outcome.

Criterion A *Population Size reduction*

Assessment Outcome: Vulnerable under Criterion A4(abc).

Justification: *Pittosporum kororoense* is under immediate threat from road construction works for the approved highway bypass project at Coffs Harbour. It is estimated that 33% of mature individuals of the species are within the roadworks project boundary with 15% recently cleared and 18% likely to be affected due to their close proximity to the roadworks. Of the total number of known stems of the species, an estimated 62% will be affected by the roadworks (Ecos Environmental 2022), i.e. an estimated 30% have been cleared and a further 32% are within the project boundary and may be affected due to their proximity to the roadworks.

The generation length of *Pittosporum kororoense* is unknown but can be estimated using the equation "Age of first reproduction + [*z* * (length of the reproductive period)], where *z* is a number between 0 and 1" (IUCN 2022). The species is a long-lived shrub that can vegetatively reproduce, and stems are thought to live for 20 years or more (Anon. *in litt.* October 2021). Mature plants are likely to have even a greater longevity (>50 years). Assuming age of first reproduction from seed to be 5-10 years and length of reproductive period to be as long as mature plant longevity (50-100 years), with continuous reproduction (z=0.5), then generation length is estimated to be between 28-55 years.

Pittosporum kororoense is projected at a minimum, to undergo a reduction of approximately 15-33% including the recent past and the next 70-100 years (3 generations or a maximum of 100 years in the future, IUCN 2022) in an index of the abundance of the taxon and decline in the quality of habitat. There is also likely to be some additional (unquantified) decline in the next 70-100 years due to ongoing threats to the species. Based on a reduction of 15-33%, the species would meet the criterion as Vulnerable.

Past clearing prior to the recent clearing for the roadworks project, would have likely reduced *Pittosporum kororoense* abundance and habitat, however decline over the last three generations has not been quantified.

Criterion B *Geographic range*

Assessment Outcome: Critically Endangered under Criterion B1ab(iii,iv,v)+2ab(iii,iv,v).

Justification: The extent of occurrence (EOO) and the area of occupancy (AOO) of *Pittosporum* kororoense are both 8 km^2 meeting the thresholds for the category Critically Endangered (EOO <100 km^2 (CR) and AOO <10 km^2 (CR)). The EOO would still meet the threshold for the category of Critically Endangered if the possible sighting south of the Coffs Harbour area was included.

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 Critically Endangered.

   Justification: Severe fragmentation: The habitat of *P. kororoense* has been extensively cleared and fragmented. There is a single population that consists of a number of sites occupying small habitat remnants. IUCN (2022) note that a single population can be severely fragmented if it is small and

may go extinct. The total population of *P. kororoense* is estimated to consist of 57-97 mature individuals with most of the sites having <10 plants (patches or genets), with the largest two sites having 12 and 29 patches or an estimated 20 and 50 genets, respectively. Additionally, fruit production is currently known to be restricted to one site. Although the species is likely to have some resilience to disturbance (recovery from underground roots), the very small population size across a number of small habitat remnants, in combination with ongoing threats suggests, on a precautionary basis, that the population of the species may go extinct and hence the species is severely fragmented.

Number of locations: The main threat to the species is ongoing loss of habitat and ongoing habitat disturbance. This will mostly impact the site affected by the roadworks project (site 1, see confidential Appendix 4) where *Pittosporum kororoense* plants and their habitat have been cleared while other plants and habitat will be disturbed by roadworks. The other remnant habitat patches nearby to site 1 (sites 2, 5, 6 and 7) are surrounded by cleared land and are additionally threatened by disturbance and edge effects from agricultural practices and urban encroachment. All these areas are considered to be the one location with regard to this threat. This is in line with the advice from IUCN (2022): "Where the most serious plausible threat is habitat loss that occurs gradually and cumulatively via many small-scale events, such as clearance of small areas for small-holder grazing, a location can be defined by the area over which the population will be eliminated or severely reduced within a single generation or three years, whichever is longer." The northern three sites (sites 3, 4, and 8) are all considered as separate locations as they are geographically more distant from each other even though the same threats are acting on them to various degrees. This gives a total of four locations.

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: met for iii, iv, and v

Justification: Continuing decline is both observed and inferred due to ongoing threats to the sites (see threats section) and the threat of clearing and disturbance due to the roadworks project at the largest *P. kororoense* site.

c) Extreme fluctuations

Assessment Outcome: not met.

Justification: The species is clonal and extreme fluctuations are not expected.

Criterion C Small population size and decline

Assessment Outcome: Critically Endangered under Criterion C1+2a(ii).

Justification: The best estimate of the number of mature individuals is 57-97. The number of mature individuals for this clonal species is estimated based on the results

of the genetics study (ReCER 2021) and on the number of patches of *P. kororoense* determined by Ecos Environmental (2022). The number of mature individuals is estimated to comprise the number of patches of plants as a lower bound, with the upper bound an estimate of the number of genets.

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: met for Critically Endangered.

Justification: Current estimates are that 15-33% of known mature individuals are under threat from road construction works within one generation (estimated to be 28-55 years), with the upper bound under the threshold for Critically Endangered.

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

Assessment Outcome: met.

Justification: Continuing decline is both observed and inferred due to ongoing threats to the sites (see threats section) and the threat of clearing and disturbance due to the roadworks project at the largest *P. kororoense* site.

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: met for Endangered.

Justification: The one remaining population that contains all known plants is estimated to have 57-97 mature individuals.

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

Assessment Outcome: met for Critically Endangered.

Justification: There is one remaining population that contains 100% of individuals.

b. Extreme fluctuations in the number of mature individuals

Assessment Outcome: not met.

Justification: *Pittosporum kororoense* is considered to be a clonal long-lived shrub and is unlikely to be subject to extreme fluctuations.

Criterion D Very small or restricted population

Assessment Outcome: Endangered under Criterion D.

Justification: The best estimate of the number of mature individuals is 57-97. The number of mature individuals for this clonal species is estimated based on the results

of the genetics study (ReCER 2021) and on the number of patches of *P. kororoense* determined by Ecos Environmental (2022). The number of mature individuals is estimated to comprise the number of patches of plants as a lower bound, with the upper bound an estimate of the number of genets. The best estimate of the number of mature individuals is therefore 57-97, which is >50 and <250, meeting the threshold for Endangered.

Even though Criterion D is met for Endangered, Criterion D2 needs to be additionally and independently assessed, as it is relevant to Clause 4.7 of the NSW Biodiversity Conservation Regulation 2017. The highest threat category for Criterion D2 is Vulnerable.

D2. Population with a very restricted area of occupancy (typically less than 20 km^2) or number of locations (typically five or fewer) such that it is prone to the effects of human activities or stochastic events within a very short time period in an uncertain future, and is thus capable of becoming CR or even EX in a very short time period.

Assessment Outcome: Vulnerable under Criterion D2

Justification: *Pittosporum kororoense* has a very restricted AOO and four locations and it is prone to habitat degradation, particularly at the largest site that is impacted by the roadworks project, such that it is capable of becoming CR or EX in a very short time in an uncertain future.

Criterion E Quantitative Analysis

Assessment Outcome: Data Deficient

Justification: There is insufficient data to assess this newly discovered species against this criterion.

Conservation and Management Actions

A conservation project is being developed by the NSW Department of Planning and Environment under the Saving our Species program. Transport for NSW (TfNSW 2022) have developed a management plan for the area affected by the Coffs Harbour bypass project.

The following is derived from the threat information and could be used to develop management actions.

Habitat loss, disturbance and modification

As the roadworks project has been approved, collaboration with TfNSW will be necessary to ensure the best outcome for the continued survival of *Pittosporum kororoense* at the largest known site. The following points apply to all sites for *P. kororoense*.

- Ensure appropriate strategic planning and environmental impact assessment is undertaken by consent and determining authorities to enable protection of all known individuals and their habitat.
- Prevent further clearing and disturbance to the sites. Develop and implement a management plan for the species that addresses minimising threats and incorporates *ex situ* conservation measures and translocation (see below).

- Negotiate for the implementation of permanent protection measures for the species and its habitat on any private land the species is found on or translocated to.

Invasive species

- Identify and remove/control invasive species including weeds and feral and domestic animals while avoiding disturbance to individuals of *Pittosporum kororoense* and their habitat. Fencing should be installed where required to protect sites from disturbance and invasive species.

Ex situ conservation

- Develop and implement a targeted *ex situ* germplasm program following best-practice guidelines (Martyn Yenson *et al*. 2021). Use genetics research results to inform translocation programs - see report by Research Centre for Ecosystem Resilience (ReCER 2022).
- Living material should be made available to a range of host botanic gardens and cover the full genetic diversity within the species. Draw on expertise from botanic gardens staff for any propagation, seed storage and translocation of *Pittopsorum kororoense* material.
- Implement national translocation protocols (Commander *et al*. 2018) if establishing additional populations or enhancing populations is considered necessary and feasible.
- Develop a targeted seed collection program for *ex situ* seed banking.

Stakeholders

- Inform landowners and managers of sites where there are known populations and consult with these groups regarding options for conservation management and protection of the species.
- Consultation and collaboration between the NSW Department of Planning and Environment and TfNSW regarding options for conservation management and protection of the species.
- Report new records of *Pittosporum kororoense* to Department of Planning and Environment.

Survey and Monitoring priorities

- Undertake further detailed systematic searches and surveys to identify any additional, currently undiscovered occurrences of the species in the Coffs Harbour district. Investigate any new sightings of the species that may occur outside the Coffs Harbour area. Follow-up action for protection of sites in perpetuity (see actions above).
- Monitoring for increased habitat degradation. Monitor and track for changes in the habitat due to the nearby road construction works at the largest site, such as the abundance of weeds, any new weed species at the site, changes in the hydrology of the habitat, dust etc.

- Regular monitoring to determine whether there is a decline in the *Pittosporum kororoense* plants. Permanent monitoring plots should be established to record growth, plant health, life history changes (flowering, fruiting, recruitment etc) and mortality of *P. kororoense* and co-occurring species. Survival and recruitment should be monitored at the patch and individual stem level for both ramets and seedlings.
- Examine the response of *Pittosporum kororoense* to any disturbance that occurs in the species habitat (e.g., stem death, resprouting, leaf browning, flowering or fruiting, recruitment).
- Monitoring for herbivory and/or illegal collections.

Information and Research priorities

- The main priority is to ensure the protection of *in situ Pittosporum kororoense* individuals whilst the road construction works are in progress and in the following years (decades). As the site impacted by the roadworks contains the largest patches of the species and the only known plants that have produced fruit, the protection of this site is important.
- Establishment of a translocation site/s as appropriate. Guidance for translocation work can be found in ReCER (2022) and TfNSW (2022).
- Develop a research program to understand the life history and ecology of the species, including recruitment mechanisms and seedling survival, pollination, breeding system, dispersal, germination biology.
- Develop propagation methods for the species to ensure a high likelihood of success with limited source material.

References

Auld TD, Denham A, Tozer M, Porter J, MacKenzie B, Keith D (2015) Saving arid and semi-arid southern Australia after over 150 years of exotic grazing pressure: have we got the time and the will? *Australian Plant Conservation* **24(2)**, 3–5.

Bachman S, Moat J, Hill AW, de la Torre J, Scott B (2011) 'Supporting Red List threat assessments with GeoCAT: geospatial conservation assessment tool.' In: Smith V, Penev L (Eds) e-Infrastructures for data publishing in biodiversity science. *ZooKeys* **150:** 117–126. The GeoCAT tool can be accessed at: http://geocat.kew.org/

Benwell AS (2023) *Pittosporum kororoense* (Pittosporaceae, Apiales), a new species from Coffs Harbour, Mid North Coast of New South Wales. *Telopea* **26**, 25-32.

Commander LE, Coates D, Broadhurst L, Offord CA, Makinson RO, Matthes M (2018) 'Guidelines for the translocation of threatened plants in Australia'. (Third Edition. Australian Network for Plant Conservation, Canberra).

Ecos Environmental (2022) Coffs Harbour Bypass, Targeted Surveys 1-3 for *Fontainea* sp. Coffs Harbour and *Pittosporum* sp. Coffs Harbour. Confidential unpublished internal report prepared for Transport for NSW.

IUCN (2012) IUCN Red List Categories and Criteria: Version 3.1. Second edition. Gland, Switzerland and Cambridge, UK.

IUCN Standards and Petitions Subcommittee (2022) Guidelines for Using the IUCN Red List Categories and Criteria. Version 15.1 Available at: https://www.iucnredlist.org/resources/redlistguidelines

Martyn Yenson AJ, Offord CA, Meagher PF, Auld TD, Bush D, Coates DJ, Commander LE, Guja LK, Norton SL, Makinson RO, Stanley R, Walsh N, Wrigley D, Broadhurst L (2021) Plant Germplasm Conservation in Australia: strategies and guidelines for developing, managing and utilising ex situ collections. Third edition. Australian Network for Plant Conservation, Canberra.

NSW TSSC (2020) Guidelines for interpreting listing criteria for species, populations and ecological communities under the NSW Biodiversity Conservation Act 2016. Version 2.1. NSW Threatened Species Scientific Committee, June 2020. Accessed at: https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Animals-and-plants/Scientific-Committee/guidelines-for-interpreting-listing-criteria-20200601.pdf?la=en&hash=113049887E7375BF0E301474D4E27287A4273F72

PlantNET (The NSW Plant Information Network System) Royal Botanic Gardens and Domain Trust, Sydney. http://plantnet.rbgsyd.nsw.gov.au (accessed 3rd November 2021) at https://plantnet.rbgsyd.nsw.gov.au/cgi-bin/NSWfl.pl?page=nswfl&lvl=sp&name=Pittosporum~sp.+Coffs+Harbour+(A.S.Benwell+342,+NSW1102028)

Roberts DG, Forrest CN, Denham AJ, Ayre DJ (2017) Clonality disguises the vulnerability of a threatened arid zone *Acacia*. *Ecology and Evolution* **7**, 9451-9460.

ReCER (2021) Report for Stage #1 of Conservation genomic project on *Pittosporum* sp. 'Coffs Harbour'. Confidential unpublished report prepared by the Research Centre for Ecosystem Resilience (Royal Botanic Garden Sydney).

ReCER (2022) Conservation genomics of *Pittosporum* sp. Coffs Harbour Phase 2. Confidential unpublished report prepared by the Research Centre for Ecosystem Resilience (Royal Botanic Garden Sydney).

Sydes MA, Peakall R (1998) Extensive clonality in the endangered shrub *Haloragodendron lucasii* (Haloragaceae) revealed by allozymes and RAPDs. *Molecular Ecology* **7**, 87-93.

Tindale MD, Kodela PG, Herscovitch C (1992) *Acacia meiantha* (Fabaceae, Mimosoideae), a new species from the Central Tablelands of New South Wales. *Australian Systematic Botany* **5**, 761–765.

Transport for New South Wales (2022) Coffs Harbour Bypass *Pittosporum* sp. Coffs Harbour & [redacted] Exclusion Zone Management Plan Issue 4 | 26 October 2022. CONFIDENTIAL DOCUMENT – not for public release.

APPENDIX 1

Assessment against *Biodiversity Conservation Regulation 2017* criteria
The Clauses used for assessment are listed below for reference.

Overall Assessment Outcome:
Pittosporum kororoense was found to be eligible for listing as Critically Endangered under Clause 4.3 (a)(d)(e)(i,iii,iv) and Clause 4.4 (a),(d)(i), (e)(i)(ii)(B).

Clause 4.2 – Reduction in population size of species
(Equivalent to IUCN criterion A)
Assessment Outcome: Vulnerable under Clause 4.2 (1)(c)(2)(a,b,c).

(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: Critically Endangered under Clause 4.3 (a)(d) (e)(i,iii,iv).

The geographic distribution of the species is:			
	(a)	for critically endangered species	very highly restricted, or
	(b)	for endangered species	highly restricted, or
	(c)	for vulnerable species	moderately restricted,
and at least 2 of the following 3 conditions apply:			
	(d)	the population or habitat of the species is severely fragmented or nearly all the mature individuals of the species occur within a small number of locations,	
	(e)	there is a projected or continuing decline in any of the following:	

		(i)	an index of abundance appropriate to the taxon,
		(ii)	the geographic distribution of the species,
		(iii)	habitat area, extent or quality,
		(iv)	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: Critically Endangered under Clause 4.4 (a)(d(i)), (e(i,iiB)).

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: Endangered under Clause 4.5 (b).

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: Vulnerable under Clause 4.7.

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.