

# Management program for **Kakadu Plum 2019-2023** (*Terminalia ferdinandiana*)



**A plan for sustainable use and livelihood opportunities from a native food plant**

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A Management Program for *Terminalia ferdinandiana* Exell in the Northern Territory of Australia  
2018-2022

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Front cover: *Terminalia ferdinandiana* by Julian Gorman

## Executive summary

The aim of this management program is to manage *Terminalia ferdinandiana* (*T. ferdinandiana*) for the benefit of Territorians and to ensure wild populations and the species' habitat are adequately maintained across the Northern Territory of Australia. This includes appropriate commercial use of wild populations and support for involvement of traditional owners in management and use.

The objectives to achieve this aim are:

1. to promote the conservation of *T. ferdinandiana* through sustainable land management and harvest
2. promote sustainable practice among key stakeholders involved in the harvest of this species
3. identify priority management measures to ensure the harvest of *T. ferdinandiana* is carried out in a sustainable manner
4. identify knowledge gaps and facilitate essential research
5. to promote public awareness and education.

*T. ferdinandiana* is a common species endemic to northern Australia, found in the Kimberley, Northern Territory Top End and Cape York regions. It occurs in pockets of extremely high density around the coastal fringe and is a common part of the mid storey of eucalypt woodlands as well as fringing wetland areas. The fruit is an important food source for a number of native mammals and birds and the flowers provide nectar and pollen for a many native bees, wasps and other insects. Aboriginal people have used the fruit and many other parts of the tree for customary purpose since time immemorial and it continues to be important to them for both subsistence and, into the future, commercial purpose.

The leaves and the fruit of *T. ferdinandiana* have exceptional phytochemical properties which have commercial application, the demand for which is likely to result in an increase of wild harvest of the fruit. Given the mature trees are usually three to eight metres in height, the fruit matures and ripens over a two to four week period and maturation is not synchronous between trees, overharvest is not likely. To harvest a large proportion of fruit in an area would be physically difficult (to reach high fruit) and require numerous trips to a single area.

Harvest permits are required for commercial harvests on all land in the NT (Aboriginal, crown and private). Harvest areas are managed through 'Take' permits so areas that are heavily harvested can be spelled if necessary if there was evidence of inadequate recruitment or if there is an impact on other species.

Increased human activity in the landscape due to increased harvest can result in increased spread of weeds, and on many Aboriginal lands there are Aboriginal Ranger groups monitoring and managing this particular issue. It is likely that sustainable use of the species encourages early burning as the harvest occurs in April/May (the late wet season/ early dry season).

Harvest should be limited to no more than 80% of fruit and further work is needed to refine future wild harvest prescriptions. Further research on the species must involve traditional owners in determining priorities and foster direct participation.

The NT Government encourages conservation through the sustainable use of wildlife (PWCNT 1997) and this management plan is consistent with that approach as it allows for livelihood benefits from country, which in turn encourages better land management.

# 1 Introduction

*T. ferdinandiana* Exell is a small to medium sized tree which is endemic to the monsoonal tropics of northern Australia and found in the savannas of north-west Western Australia through the wet/dry tropics of the Northern Territory and the Cape York area of Queensland (Figure 1). Over this broad distribution it is thought to occur most densely in the coastal fringe in a diversity of vegetation and soil types. It is well known for having fruit with exceptional high levels of ascorbic acid (Vitamin C) and is also documented as having high levels of ellagic acid, which has anti-oxidant values, making it an attractive natural ingredient for its nutraceutical, pharmaceutical, anti-microbial and preservative values (Konczak et al. 2010, 2014; Williams et al. 2014; Ohno et al. 1999).

Aboriginal people have a long history of medicinal and nutritional customary use of this species and have been recorded harvesting various products (fruit, leaf, bark and sap). There are many clan groups that hold knowledge about its ecology and ethno-medicinal uses (Brock, 2001; Isaacs, 1987; Lindsay et al., 2001; Puruntatameri et al. 2001; Raymond et al., 1999). The high Vitamin C content of the fruit has been documented as early as the 1980s (Brand et al. 1982), and both NT and WA Agriculture departments have in the past released Agnotes promoting the species' horticultural potential. There has been some horticulture investigations and cultivation trials of this species in the Broome and Darwin areas (Clarke 2012), but despite the potential and increasing demand there has been limited progress in commercial development.

With increased commercial demand there has been an increase in wild harvest from government and Aboriginal land over the last two decades (section 2.4.2), prompting some concerns around the sustainability of wild harvest (e.g. damage to trees and competition with native fauna for fruit). This has prompted the development of a management plan that will consider customary and commercial use and promote the long term conservation of this species, with benefit for the habitats it occupies and species that depend on it for food and shelter.

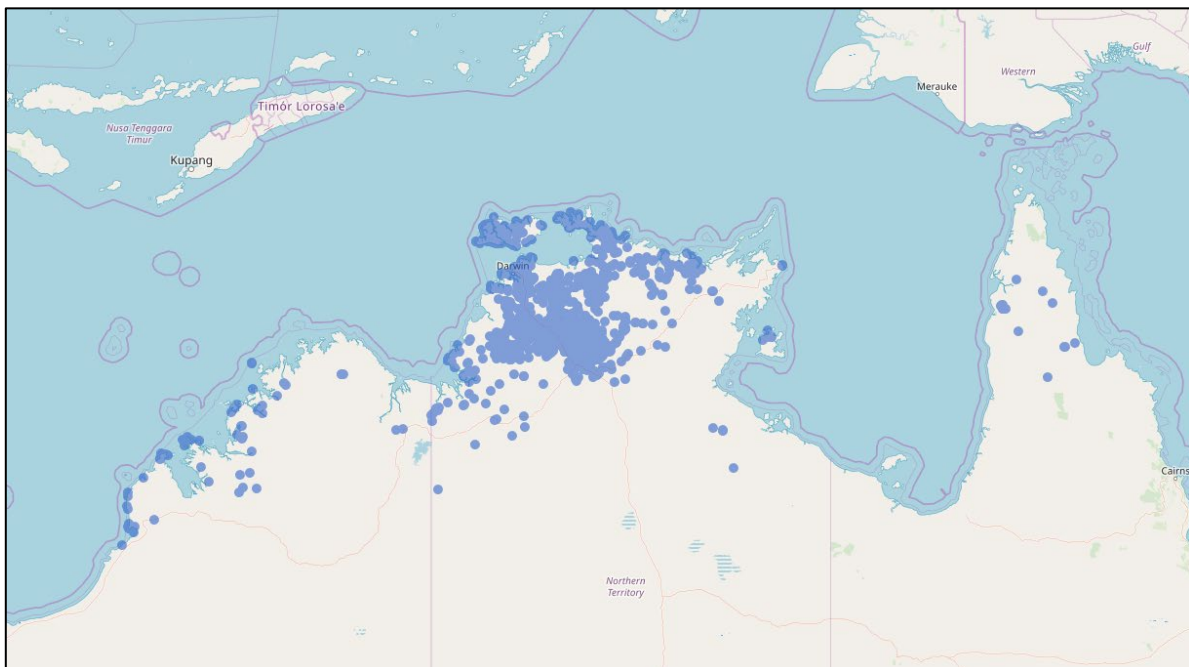


Figure 1: Distribution of *T. ferdinandiana* (Atlas of Living Australia: State agency, herbaria and virtual herbaria records).

## 1.1 Aim and objectives

The aim of this management program is to manage *T. ferdinandiana* for the benefit of Territorians and to ensure wild populations and the species' habitat are adequately maintained across the [historical](#)<sup>1</sup> range in the Northern Territory (see section 31(1) of TPWC Act 1977). This includes permitting appropriate commercial use of wild populations of the species and supporting participation of, and delivery of benefits to, traditional owners.

The objectives of the program are to:

- i) promote the conservation of *T. ferdinandiana* through sustainable land management and harvest
- ii) promote sustainable harvest practice among key stakeholders involved in the harvest of this species
- iii) identify priority management measures to ensure the harvest of *T. ferdinandiana* is carried out in a sustainable manner
- iv) identify knowledge gaps and facilitate essential research
- v) promote public awareness and education of the Northern Territory Government strategy for conservation through the sustainable use of wildlife (PWCNT 1997).

## 1.2 Species

*T. ferdinandiana* Exell is part of the family Combretaceae, which contains 20 genera and 500 species that are widespread in tropical and subtropical regions of the world (Dunlop et al. 1995). The genus *Terminalia* consists of about 200 species, of which 29 species or subspecies are native to Australia (Dunlop et al. 1995), with 14 species in the Kimberley region of Western Australia (WA), 12 in the Northern Territory (NT) and 16 in north Queensland (QLD) (Pedley 1995). Although there is some taxonomic uncertainty, *T. ferdinandiana* is endemic to northern Australia and ranges from just south of Broome (WA) through both the coastal and inland areas of northern WA into the NT and QLD, where it occurs in the wet/dry tropics from the west, across Arnhem Land to the Gulf of Carpentaria (Dunlop et al. 1995, Pedley 1995).

*T. ferdinandiana* is a small to moderately sized semi-deciduous tree (Pedley 1995) which was originally described as *T. edulis* by Ferdinand von Mueller in 1860 (Williams 2011). It is closely allied to *T. carpentariae*, *T. hadleyana*, and *T. latipes*, of which it is sometimes considered a subspecies *T. latipes psilocarpa* (Byrnes 1977; Wheeler 1992; Pedley 1995). It is also sometimes combined with *T. prostrata* (Dunlop et al. 1995). The exact taxonomy of *T. ferdinandiana* is uncertain due to there being a number of natural hybrids (Kenneally et al. 1996, Cunningham et al. 2009) and further taxonomic work needs to be conducted.

Across its range there is some variation in flowering and fruiting, but generally *T. ferdinandiana* flowers at the end of the dry season (September to November) and fruits from the middle of the wet season to the early part of the dry season (January to June). It produces smooth, fleshy ovoid drupes (fruits) which can be highly variable in shape and are yellow–green when ripe (Brock 2001).

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<sup>1</sup> [http://www5.austlii.edu.au/au/legis/nt/consol\\_act/tpawca451/s31.html](http://www5.austlii.edu.au/au/legis/nt/consol_act/tpawca451/s31.html)

## 1.3 Responsible authority

### What's in a name?

*Terminalia ferdinandiana* is the established scientific (Latin binomial) name. The species is often called Kakadu Plum in English and from a product marketing perspective there may be value in using this label consistently to increase awareness of the range and value of the products derived from the plant with consumers. In the Maningrida area and some other regions, the species is commonly called billygoat plum in English as well as green plum and salty plum. There are many different names for this species in Aboriginal languages with most languages having two or more names, depending on the size of the tree or the area it is harvested from. Names include man-djiribbij in Kuninjku, Mardakudj in Ndjebbana and mu-jiburrbarlmuna in Burarra and Mi Marrarl in the Thamarrurr Region, Elu and Kereey in Malak Malak, Morlag in Mangarrayi and Yangman, marnamin in Wagiman and warabitji in Warray.

The management and regulation of all aspects of harvest from the wild and use of protected wildlife in the Northern Territory is administered under the Territory Parks and Wildlife Conservation Act 1999 (TPWC Act). The Northern Territory Government, through the Department of Environment and Natural Resources (DENR) and the Department of Tourism, Sport and Culture (DTSC) administers the TPWC Act. DENR is responsible for Part IV Divisions 1 to 5 of the act, which covers such issues as the determination of appropriate conservation status of plants and animals (the listing of wildlife species) and development of management plans. DTSC is responsible for Part IV Divisions 6 which includes the issuance of research and commercial use permits. In a formal management plan under the TPWC Act, DENR is responsible for overseeing the harvest allocation process and works with DTSC to ensure appropriate permits are issued.

## 1.4 Legislative, national and international obligations

### 1.4.1 Northern Territory

Territory Parks and Wildlife Conservation Act 1999 (TPWC Act).

*T. ferdinandiana* is not listed as a threatened plant nor is it classed as protected when not in a park, reserve, sanctuary, wilderness zone or area of essential habitat. However, all wildlife that is collected for commercial purpose, including the harvesting of fruit and leaves, requires a permit to take or interfere with wildlife under section 55 of the TPWC Act.

The Parks and Wildlife Commission may formulate and implement programs for the purpose of the protection, conservation, sustainable use, control and management of wildlife under section 32 of the Territory Parks and Wildlife Conservation Regulations 2001.

In addition to the requirements for permits to harvest fruit or leaves from *T. ferdinandiana* for commercial purposes, provision exists for support by the Parks and Wildlife Commission of the Northern Territory in the management of *T. ferdinandiana* populations on various types of land tenure. The legislative basis for such support under the TPWC Act is summarised below:

- On reserve land: Parks and reserves may be declared under section 12 and plans of management are prescribed under sections 18 and 19. The management of *T. ferdinandiana* populations may be addressed through park plans of management.
- On Aboriginal land: the Parks and Wildlife Commission may enter into an agreement with Aboriginal Land holders relating to schemes for the protection and conservation of wildlife under section 73.

On private land: the Parks and Wildlife Commission may enter into an agreement with a land owner relating to a scheme for the protection and conservation of wildlife under section 74.

A licence may be required to take plants or for plant production for commercial purpose on Pastoral or Crown Lands, under the Pastoral Land Act 1992 and Crown Lands Act 1992.

## 1.4.2 Commonwealth Government

Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act).

The Federal Government Department of Environment through the Environment Protection and Biodiversity Conservation Act 1999 regulates the import to and export from Australia of all Australian native animals, or their parts.

*T. ferdinandiana* is not listed as threatened under the Federal legislation but has regulations for international export as it is a native Australian species.

To be able to export an Australian native wildlife specimen (unless exempt), it must come from an approved program such as a Wildlife Trade Operation. To be listed as an Approved Wildlife Trade Operation requires a Wildlife Trade Operation Proposal outlining details of harvest operation be submitted. *T. ferdinandiana* is not exempt so proponents need to abide by this regulation to be granted an export permit. To be an Approved Wildlife Trade Operation requires an endorsed Management Plan ensuring sustainable harvest and maintenance of natural populations.

## 1.4.3 International regulation of export

*T. ferdinandiana* is not listed under the Convention on International Trade in Endangered Species (CITES) so there is no international legislation that should affect the export of processed *T. ferdinandiana* products. There are however, restrictions on the export of genetic material (seed, tissue culture etc.) without prior consent which would be covered under the Convention for Biological Diversity Agreement 1992 (see <https://www.cbd.int/convention/>) including the application of the [Nagoya protocol](#)<sup>2</sup> for many importing countries. Issues of access and benefit sharing are outside the scope of this plan and any applications for use of the species or tissue material for bio-discovery purposes would require separate consideration.

## 2 Background information

The NT Government has developed a strategy for the conservation through the sustainable use of wildlife (NTG 1999) which:

- encourages the sustainable use of wildlife for commercial purposes
- endorses ecological sustainability
- promotes landowners as being the beneficiaries of sustainable use of wildlife
- encourages the development of management plans for species to ensure sustainable use (e.g. crocodiles, cycads, magpie geese).

Wildlife, and the use of wildlife, are very important to Aboriginal people in remote settings of the Northern Territory, for customary purposes as well as opportunity for enterprise to benefit livelihoods (Altman 2001; Altman and Whitehead, 2003; Fordham et al. 2010; Gorman et al. 2006, 2008;

<sup>2</sup> <https://www.cbd.int/abs/doc/protocol/nagoya-protocol-en.pdf>



Nikolakis 2010). The NT Government supports the sustainable use of a number of native flora and fauna (crocodiles, cycads, barks and fibres), which have made significant contributions to the NT economy and contributed to livelihoods.

A major benefit in increased livelihood opportunities to local people in remote NT is that they are then able to remain living on that country and maintain cultural connections and manage their land (Gorman and Vemuri 2012). NT landscapes require active management, with wildfire and feral pests (plants and animals) causing serious environmental damage. Human population density is extremely low (0.2 person/km<sup>2</sup>) across the NT (ABS 2016) and without people living on and accessing country, land management at an appropriate scale will continue to be difficult. Enterprise development on Aboriginal land can provide livelihood opportunities that help maintain human population density in these remote landscapes, which in turn can contribute to good land management outcomes.

*T. ferdinandiana* has exceptional properties and commercial potential and, along with its cultural and customary importance, can provide socio-economic, ecological and customary benefit if managed appropriately (Gorman et al. 2016).

## 2.1 Socio-economic significance

The commercialisation of *T. ferdinandiana* presents an economic opportunity for vast areas of tropical savanna that are currently relatively economically unproductive and sparsely populated. This economic base could help support Aboriginal people to maintain or retain connection with their traditional country, benefiting people and the environment.

The majority of the natural occurrence of *T. ferdinandiana* falls on Aboriginal-owned freehold land. Efforts are being made to involve Aboriginal people in economic opportunities derived from the commercialisation of *T. ferdinandiana* (Gorman et al. 2016). To meet market demand in the short term would require a coordinated wild harvest of fruit from across its range. Given the species distribution, density and yields this can be achieved in an ecologically sustainable manner if carefully managed. To ensure Aboriginal involvement and benefit, wild harvest needs to incorporate the cultural and social protocols of the different Aboriginal groups on their Clan Estates. Past harvests in the Thamarrurr Region of the NT (300km south west of Darwin) have shown that hundreds of people from one township alone are willing to partake in wild harvest. The harvest has provided community members collectively with tens of thousands of dollars (Gorman et al. 2016).

In the longer term, the large market for this fruit is likely to drive more conventional cultivation, requiring agronomic research and development. There is likely to be a variety of cultivation practices acceptable to Aboriginal people such as mixed and enrichment plantings, and it is critical that Aboriginal people are given the support and advice to be able to participate in the growth of this industry in a way that suits their aspirations, knowledge and cultural protocols. Such development opportunities are already recognised - for example, the Thamarrurr community has been involved in trials, harvesting, value-adding, marketing, training, employment and research of the species for over a decade (M. Bentivoglio, pers. comm.).

### 2.1.1 Land tenure

Commercial use on Crown Land and Aboriginal land under the Aboriginal Land Rights (Northern Territory) Act 1976 (ALRA) are regulated differently. Both required a Take Permit from the NT Government which is concerned with sustainable use; however, on ALRA land there are cultural protocols and additional legislation relating to access and authority. This is done through section 19c of the ALRA, which ensures Traditional Owners authorise any commercial activity on their land; generally through a Land Use Agreement (LUA). The Northern Land Council is tasked to assist in this area through ensuring compliance with the agreement. It is important that decision making is made in the right

way on Clan Estates, that Aboriginal people are empowered in the process and that cultural values are protected in the process. There are cultural taboos that are used to dissuade poor management practice and Aboriginal Ranger groups would generally encourage good practice and monitor the harvest process and effect on natural populations.

Under the Crown Lands Act 1992, licences for a period of no longer than 12 months may be granted to collect timber, wood, bark or any other substance on unreserved crown land which could therefore allow commercial harvest. Fees and specific terms and conditions apply.

### 2.1.2 Economic values

There is a diversity of markets for *T. ferdinandiana* including nutritional, preservative, pharmaceutical and nutraceutical. In the 1990s and early 2000s it was a major ingredient of a range of bush food-based condiments sold through Coles/Myers. In the 2000s it was part of a supplementary health tablet called “Ambrotose” ® produced by an American manufacturing company, Manatech Pty Ltd. More recently the Prawn Industry has used an extract of *T. ferdinandiana* to prolong the life of cooked prawns, and it has been used as a preservative in many other ways. A number of Australian and International companies are using it in body products for its anti-oxidant values and there is interest from health drink companies and many other applications (see Gorman et al. 2016; Cunningham et al. 2009).

## 2.2 Population estimates and trends

The density of *T. ferdinandiana* trees of fruit-bearing age has been recorded in excess of 500 trees/hectare (ha), with the highest densities on or near the coast (Woods 1995). A study of harvest sites in the Darwin region found to an average density of  $272 \pm 169$  mature trees (>2m in height) per ha (Whitehead et al. 2006). At intervals from the coast of central Arnhem land to 50km inland densities averaged  $14.4 \pm 24.3$  trees per ha with the highest density being along the narrow coastal strip (82 trees per ha) and on clay soils 40km inland (31 trees per ha) (Gorman et al. 2006; Whitehead et al. 2006). In certain areas densities are extremely high and could be thought of as natural plantations.

## 2.3 Distribution of *T. ferdinandiana*

*T. ferdinandiana* is a major understory component of *Eucalyptus tetradonta* and *Eucalyptus miniata* woodland and open forest vegetation in the NT. This vegetation type is widespread across the northern part of the NT (Woods 1995), so that *T. ferdinandiana* is both widespread and abundant. The few studies that have measured this species' density show that there is high variability across its range (Woods, 1995, Whitehead et al. 2006), likely to be related to soil types, drainage, rainfall and disturbance (particularly fire).

*T. ferdinandiana* has been found at its highest density along the coast of northern Australia in eucalypt dominated woodlands. It is deciduous and, after dropping it leaves in early to mid-dry season (June/July), it is inactive until the build-up, when around November it throws new leaves and flowers soon afterwards. The production of this new growth requires a store of food in lignotuber and/or in the trunk. This means that it is likely that the production one year is dependent on the conditions of the previous year and how much resource has been stored for the new season. In the tropical savannas, herbivory, fire and water availability combine to play an important role in the structure and dynamics of systems (Scholes and Archer 1997; van Langevelde et al 2003). Research in tropical savannas has shown that a common outcome of competition for water resources and frequent fire is clumping (Groen et al 2008). *T. ferdinandiana* has been observed to show this trend having been observed clumped at extremely high density on high clay soils. This contrast with its pattern in in other vegetation types where they are less clumped.

Fire is a major disturbance factor in the tropical savannas. In areas with high fire frequency eucalypts are suggested to have a competitive advantage over non-eucalypts because of their ability for epicormic growth (Ryan and Williams 2011; Bond et al. 2012). Recruitment of non-Eucalypts is retarded as frequent fires burn juveniles back to ground level each year and they must rely on lignotubers to grow the following year; when they may be again burnt. To escape the ground layer they must grow above a minimum size during a fire-free interval. In the tropical savannas, especially in eucalypt woodlands, fires are often annual or biannual. Recruitment of non-eucalypts like *T. ferdinandiana* require a longer fire free-interval and the current fire pattern has resulted in their density and demographics being skewed to larger mature trees across much of their distribution. In areas where *T. ferdinandiana* are locally abundant, fire regimes are probably less frequent and less intense allowing increased recruitment and survivorship.

These environmental variables, especially fire regimes, make it difficult to define the local occurrence and density *T. ferdinandiana* with any accuracy. They are found in the tropical savannas as far south as Broome in WA but appear to be most prolific in areas above 1,000mm annual rainfall. They occur on a range of soils from the relatively well-drained sandy loams to the seasonally inundated clay soils surrounding wetland areas. It is likely that fire regime may be determining the pattern in which they occur in these vegetation types. There have been unsuccessful attempts to map distribution of *T. ferdinandiana* at different scales using remote sensing techniques. These were hindered by the co-occurrence of a number of species which grow new leaves in the build-up, and no unique reflective signatures for *T. ferdinandiana* have been identified.

In summary, although the general distribution of *T. ferdinandiana* is well known, factors affecting local distribution and density are not fully understood.

## 2.4 History of use

### 2.4.1 Aboriginal use

Aboriginal people have a long history of use of *T. ferdinandiana* and fruit was consumed by Aboriginal people on hunting trips for quick energy and refreshment (Brock, 2005). Central Arnhem Land tribes regarded it as more a medicine than a food (Isaacs, 1987). In addition to the fruit being eaten for medicinal purposes (to treat colds and congestion; Lindsay et al., 2001; Puruntatameri et al. 2001; Raymond et al., 1999) the sap was roasted and the bark was boiled in water and used to treat skin conditions and sores, or drunk as a tea for colds and flu (Lindsay et al., 2001). Traditionally, both the fruit and seed of *T. ferdinandiana* were eaten raw.

### 2.4.2 Commercial use

There has been a relatively long history of commercial use of *T. ferdinandiana* dating back to the late 1990s when it was bought in small amount for its nutritional value. See Gorman et al. 2016 for more information about history of commercial use in the NT.

There has been 20 years of commercial harvest of *T. ferdinandiana* in the Northern Territory as shown in the NTG permit system (see Figure 2). These permits cover a variety of land tenure (mainly crown land and Aboriginal land). The Take Permit is a request to take a certain amount of fruit from a proposed area. The request is assessed by the Permits Office and if deemed sustainable and having permission of the land owner (on Aboriginal Land administered by the Northern Land Council) then a Take Permit is granted. The proponent is required to submit a permit return which states how much fruit was actually collected. Currently a royalty is paid on this amount if collected on Crown Land or Leasehold Land.

The declared amounts of fruit collected are based on an honesty system. Given that royalties are calculated on this volume it is possible that it may be under declared. This might account for the substantial difference between the Take Permits applications and the permit returns.

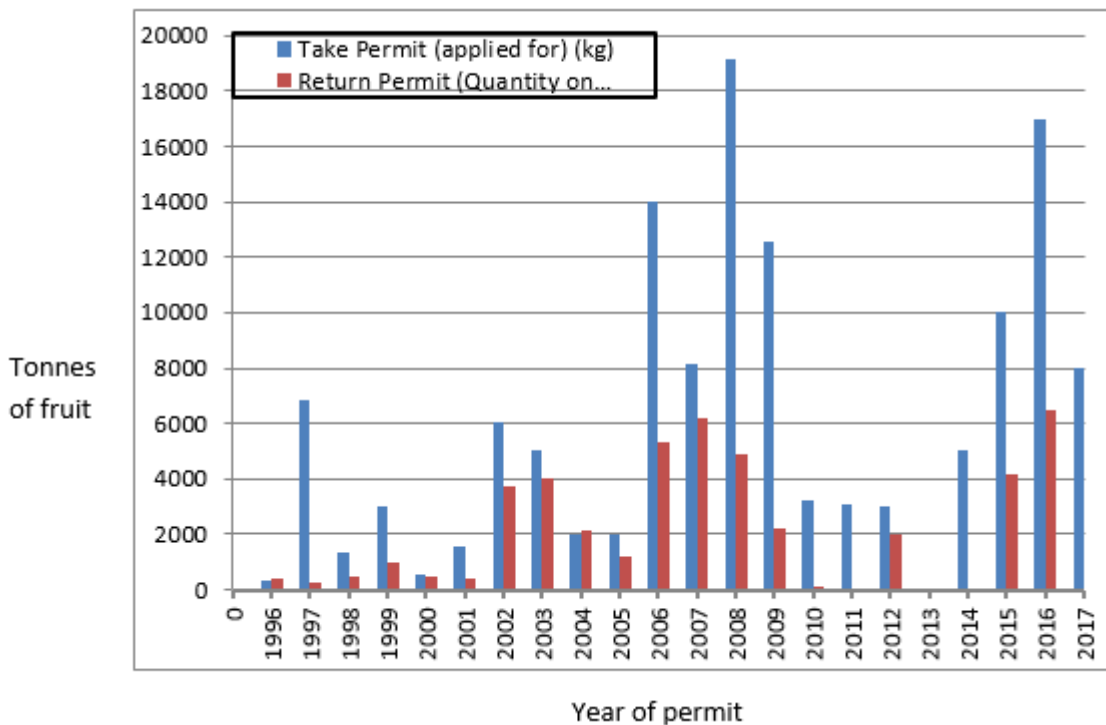


Figure 2: TPWCA permits applications and returns for commercial harvest of *T. ferdinandiana* between 2006 and 2018.

### 3 Impacts of harvest

There are a number of potential impacts from wild harvest of *T. ferdinandiana* that need consideration. They include physical harm to the trees, reduced recruitment; a reduced food source for native animals that rely on the fruit, spread of weeds and altered fire regimes from increased human activity in the area.

#### 3.1 Physical harm to trees

During wild harvest in some regions there have been a number of branches being broken and even trees cut down to access fruit. This behaviour is usually the exception but has been noted by landowners and an Aboriginal Ranger Group in the Thamarrurr region as an issue of concern. In response a Territory Natural Resource Management-funded project was conducted to measure the fate of trees that had been damaged by harvesters. *T. ferdinandiana* has been found to coppice from the nodes below points where they have been cut and so will regrow. It has been found to take approximately three years of regrowth before fruit is produced. Additionally, trees cut close to the ground are more likely to be impacted by fire. This behaviour is not accepted by Traditional Owners in the Thamarrurr region and they have implemented a number of strategies to discourage it, including education and training through a pre-harvest induction, banning pickers that are known to damage trees, and restricting harvest in areas where trees have been damaged. Typically community groups quickly enable themselves to protect their resource base from destructive harvest procedure if their livelihoods are threatened (Frost and Bond 2008).

On crown land the NT Government has records of where proponents have picked, so could check these areas and take action if trees are being poorly treated by harvesters.

### 3.2 Impact on recruitment

*T. ferdinandiana* is a tree which grows to six metres in height and has much diversity in form. The fruit occurs on racemes in small or large bunches depending on pollination success coupled with climatic conditions. The species is thought to have a mass flowering which is synchronous across local stands or populations and which continues for a number of weeks – generally between November and January - often with more than one wave of flowering. The best time to harvest the fruit is when the ascorbic and ellagic acids levels are at their peak, which is at the very end of the fruits' maturation phase (growing phase) and before the fruit starts to ripen. The fruit along each raceme is usually a slightly different age because the flowers were active at slightly different times and the fruit on different racemes may also be different ages. Therefore the fruit is not all ready to pick at the same time and not all fruit on a tree is likely to be picked. Ticktin (2015, 2004) gives examples and refers to harvests of up to 95% of the fruit that have no long term impact on populations; rather it is long lived plants that produce few seed that are more threatened by over harvest. Given the height and lack of access to harvestable fruit as well as variability of ripeness of fruit of *T. ferdinandiana* there is a low likelihood of impact on recruitment and any impact is likely to only be at a local level. Anecdotal evidence is that there is seed on the ground subsequent to the fruiting season in heavily harvested areas.

### 3.3 A reduced food source for native animals that rely on the fruit

There are a number of native mammals and birds that have *T. ferdinandiana* fruit as part of their diet, including possums, black-footed tree rats, red-tailed black cockatoos and other frugivorous birds. As described in section 3.2, there is still likely to be a substantial proportion of fruit left on trees where it is less accessible to harvesters. Additionally harvesters target clumps of *T. ferdinandiana* trees and do not bother harvesting trees at low density due to reduced return for effort. Ripe fruit that animals are likely to target is different to the mature fruit that harvesters are targeting.

### 3.4 Spread of weeds and fire

With increased access to country by people commercially harvesting fruit there is an increased threat of unintentional spread of weeds. The pattern of weeds following human movement and disturbance is well known. This threat has been identified by Aboriginal Ranger groups, who respond to weed outbreaks resulting from Aboriginal people moving between townships and their clan outstations. However, there are many benefits of have people visiting country which is seldomly visited as they can detect and report foreign animals and plants in that area, burn country appropriately (*T. ferdinandiana* harvest coincides with the early dry season), facilitate attendance to cultural responsibilities and allow collection of other bush tucker to supplement their diet, with considerable health benefit. The current view of natural resource management agencies is that the benefits of having people visiting country will balance or outweigh the potential for increased spread of weeds.

## 4 Research gaps

Based on the very broad distribution and large population of *T. ferdinandiana* it is safe to assume that, for the foreseeable future, the wild harvest of fruit would not be expected to have any negative impact on the conservation of this species. Indeed, as well as considerable economic benefit there is potential for conservation benefit from wild harvest through improved fire regimes, surveillance for weeds and pests and continuation of traditional land management practices.

However, to promote conservation of *T. ferdinandiana* in the longer term and to maximise economic benefit to the Northern Territory there are numerous knowledge gaps that should be investigated. There are many benefits from directly involving traditional owners in research programs, including insights from traditional knowledge, mutually determining areas of highest priority for investigation and improving long term uptake of research outcomes.

## 4.1 Taxonomy

The uncertainty surrounding the taxonomy of *T. ferdinandiana* and the known variation in phenotypic and chemical properties should be investigated. It is likely that this variation will provide opportunity for market segmentation as certain qualities will be desired by different markets. There may also be implications for management of the species if certain “varieties” are selectively harvested. For example, at present there is uncertainty amongst taxonomists as to whether a grown form of *T. ferdinandiana* is actually a different species, *Terminalia prostrata*.

## 4.2 Environmental parameters and distribution

As noted, the local occurrence and density of *T. ferdinandiana* is variable from scattered trees to dense groves, likely to be related to soil types, drainage and rainfall and disturbance (fire). An understanding of environmental determinants of distribution and demographics will inform an understanding of these patterns and also assist in understanding the landscape-wide management required for the conservation of the species.

Dense groves of this species appear to occur adjacent to inundated areas. These areas are the most likely to be subject to wild harvest. An understanding of the role of soil moisture in the formation of the dense groves would inform their management. A better understanding of the factors that lead to the development of dense patches would inform a population estimate for *T. ferdinandiana* and allow for a better estimate of a sustainable harvest limit. Dense patches may also be clumping which could also be in response to fire (Groen et al. 2008) and these patterns and responses to environmental variables need to be better understood as they may help in predicting distribution maps

### 4.2.1 Impacts of fire

An understanding of the role of fire- particularly intensity and frequency – in fecundity, recruitment and survivorship, will allow land managers to implement a fire regime that favours *T. ferdinandiana*. Determining the optimal fire interval to manage fruit production and tree recruitment, growth and survival is an identified research priority.

## 4.3 Harvest and alternative production systems

A greater understanding of the activities undertaken by people (particularly aboriginal people) whilst harvesting the fruit will lead to a quantification of economic and social co-benefits. To provide a greater understanding of the economic opportunity that wild harvest of *T. ferdinandiana* has, especially for remote communities, a better understanding is required of the economics for harvesters (e.g. how much can be harvested in an hour; how far do people need to travel?).

With the predicted rise in market demand it is likely that cultivation will also be a future component of the supply chain. To support the sustainable development of cultivation the feasibility of alternate production systems, including enrichment planting and mixed planting should be investigated.

To support the development of cultivars requires an understanding of the species’ variability coupled with requirements of particular markets. There is also a requirement for research into the horticultural requirements of the species (e.g. fertilizer, irrigation, pest management). Whilst intensive horticulture and

development of commercially farmed crops is outside the scope of this Management Plan, such research may inform future wild use programs.

#### 4.4 Permit conditions

There is no information from existing commercial harvest that suggest a requirement to set highly prescriptive harvest regimes, although it is acknowledged that more data need be collected, especially if the total harvest increases over time. Based on current understanding, the following permit conditions for wild harvest of *T. ferdinandiana* are recommended:

1. Harvest should be limited to no more than 80% of the fruit from each tree in any year.
2. Harvest from very young trees should be avoided and all harvesting should aim to minimise damage to the trees. Harvesting from damaged trees should be prohibited.
3. Data on the amount of fruit harvested should be collected and made available to the Department for management purposes. Any such data should be treated as being the intellectual property of the landowner and not made publicly available in any form that reveals specific harvest locations without the permission of the owner.
4. Plants or plant material collected, and any progeny or derivatives thereof, must not be used for bio-discovery purposes unless specifically permitted. If recipients and/or permit holders wish to undertake bio-discovery the recipient/permit holder must first obtain written approval from the Northern Territory Department of Trade, Business and Innovation. Any future research on the samples collected and other manipulation of samples, progeny or derivatives that the Northern Territory Department of Trade, Business and Innovation deemed to comprise bio-discovery will be subject to a separate agreement between the recipient/permit holder and the resource access provider, consistent with the Northern Territory Biological Resources Act 2006.
5. The permit holder agrees to notify any third parties receiving the samples of their obligations under the Biological Resources Act 2006 if the sample, any progeny or derivatives can potentially be used for bio-discovery purposes.

Permit conditions may vary in the light of new information collected during the life of this management program.

To inform permit management a better understanding of the proportion of fruit that is actually harvested in a favoured harvest area is required. A measure of the amount of seed found on the ground post-harvest in heavily harvest areas would provide a simple measure of maintenance of potential for recruitment.

An understanding of the level of compliance with permit conditions is also required. A method of matching permits returns with commercial sales would be of benefit.

#### 4.5 Issues register

During consultation the development of this plan, a number of issues were raised that require further information and stakeholder input prior to making any formal management recommendation. These include:

- appropriate spatial allocation of the commercial harvest
- issues of access and benefit-sharing
- existence and possible implications of different plant varieties or formal sub-specific taxonomic differences

- appropriate monitoring of offtake
- appropriate fire regimes to maximise recruitment, yields and protect patches of high yielding trees
- mechanisms to ensure research coordination and real collaboration between Traditional Owners, researchers and government agencies to address identified priorities of Traditional Owners, including land management / horticulture techniques and value adding / product development
- the restrictions on Aboriginal corporations related to section 19 of the Aboriginal Land Rights (Northern Territory) Act 1976 when operating on their own land.

Actions have been included in this plan to address these issues with the expectation of progress prior to the next review and refinement of the plan. As noted above, information to date does not suggest that the current levels of harvest are detrimental to the conservation of this species or other dependent species and there are some harvest programs that are returning real value to Aboriginal communities. Therefore, there is no significant risk in continuation of the harvest whilst issues around absolute take thresholds and improved monitoring are investigated.



## 5 Annual actions and performance measures

### Milestone Matrix for Kakadu Plum Management Program 2019 to 2024

#### Objective 1: To promote the conservation of *T. ferdinandiana* through sustainable land management/harvest practices

Milestone	Performance measure	Action officer/ partners	2019	2020	2021	2022	2023	2024
Develop a GIS database of the distribution abundance and harvest of <i>T. ferdinandiana</i> to assist with providing advice to minimise the impact of harvest on local <i>T. ferdinandiana</i> populations.	Comprehensive database for Top End developed and maintained.	DENR, Territory NRM, Nth Sust Aboriginal Kakadu Plum Alliance (NAAKPA).	Develop	Implement, ongoing	Implement, ongoing	Implement, ongoing	Implement, ongoing	Implement, ongoing
Work with Stakeholder groups including TOs and Industry to demonstrate the value of commercial harvest of <i>T. ferdinandiana</i> on all land tenures, and that the use is consistent with the Territory Parks and Wildlife Conservation Act and broader conservation objectives	Sustainable use is supported by public and key decision makers.	Manager Wildlife Use DENR/DTSC.	Ongoing	Ongoing	Ongoing	Ongoing	Ongoing	Ongoing
Ensure Fire and weed management initiatives are consistent with <i>T. ferdinandiana</i> management requirements.	Awareness of management requirements by relevant NRM program staff.	DENR/ Territory NRM/ Ranger Groups	Ongoing	Ongoing	Ongoing	Ongoing	Ongoing	Ongoing

**Objective 2: Promote sustainable practice among key stakeholders involved in the harvest and/or management of this species**

Milestone	Performance measure	Action officer/ partners	2019	2020	2021	2022	2023	2024
Assess all permit applications for commercial use of <i>T. ferdinandiana</i> , ensure permit conditions are set in accordance with the provisions of this management program and issue permits as appropriate under the Territory Parks and Wildlife Conservation Act 1976.	Timely processing of permit applications	Manager Wildlife Use DENR/DTSC	Ongoing	Ongoing	Ongoing	Ongoing	Ongoing	Ongoing
Monitor and audit all harvest applications, approvals and returns, and investigate and resolve any discrepancies.	Improvement in level of compliance and support for information gathering by stakeholders.	Manager Wildlife Use DENR/DTSC/ NAAKPA/ Industry sectors	Ongoing	Ongoing	Ongoing	Ongoing	Ongoing	Ongoing
Develop rapid assessment protocols to provide qualitative and quantitative assessment of <i>T. ferdinandiana</i> populations	Ease of use, uptake and collection of useful data.	DENR/ Territory NRM/ Ranger Groups	Develop	Trial	Implement	Implement	Implement	Review and revise where necessary
Implement qualitative and quantitative assessment in conjunction with selected representative sustainable harvest operations to monitor the management and response of <i>T. ferdinandiana</i> populations	Uptake and protection of Traditional owners and relevant commercial operators Intellectual Property.	DENR/ Territory NRM/Ranger Groups	Develop	Trial	Implement	Implement	Implement	Review and revise where necessary

Milestone	Performance measure	Action officer/ partners	2019	2020	2021	2022	2023	2024
Compare <i>T. ferdinandiana</i> population data from harvested and unharvested sites to guide management prescriptions.	Statistically valid comparisons.	DENR/ Territory NRM/ Ranger groups	Ongoing	Ongoing	Ongoing	Ongoing	Ongoing	Ongoing

**Objective 3: Identify strategic management measures to ensure the harvest of *T. ferdinandiana* is carried out in a sustainable manner**

Milestone	Performance measure	Action officer/ partners	2019	2020	2021	2022	2023	2024
Assess all permit applications for commercial harvest of <i>T. ferdinandiana</i> on all land tenures, ensure permit conditions are set in accordance with the provisions of this management program and issue permits as appropriate under the Territory Parks and Wildlife Conservation Act 1976.	Permits issued are consistent with this Management Plan.	Manager Wildlife Use DENR/DTSC	Ongoing	Ongoing	Ongoing	Ongoing	Ongoing	Ongoing
Develop a strategic industry plan that meshes the sustainable wild harvest with long term economic outcomes.	Thriving industry with returns going back to Traditional owners. Industry, Government and Traditional owners objectives aligned.	Manager Wildlife Use NAAKPA /Industry Sectors/DBTI	Consult	Develop	Finalise	Implement	–	Review

**Objective 4: Identify knowledge gaps and facilitate essential research**

Milestone	Performance measure	Action officer/ partners	2019	2020	2021	2022	2023	2024
Assess all permit applications for research on <i>T. ferdinandiana</i> and issue permits as appropriate under the Territory Parks and Wildlife Conservation Act 1976.	Permits issued are consistent with this Management Plan.	Manager Wildlife Use DENR/DTSC.	Ongoing	Ongoing	Ongoing	Ongoing	Ongoing	Ongoing
Develop a research plan in collaboration with Traditional Owners and researchers.	Uptake of research program by University/CSIRO and Government researchers that delivers long-term benefits to indigenous communities.	DENR/ Territory NRM/ NAAKPA.	Consult	Develop	Finalise	Implement	–	Review
Provide research results on the impacts of harvesting on <i>T. ferdinandiana</i> to the public.	Continuing broad acceptance of sustainability.	DENR, researchers' and stakeholders' media groups.	Ongoing	–	–	Ongoing	Ongoing	Ongoing

**Objective 5: To promote public awareness and education**

Milestone	Performance measure	Action officer/ partners	2019	2020	2021	2022	2023	2024
Maintain a publicly accessible display <i>T. ferdinandiana</i> with interpretive information.	Community awareness of the value of the species.	Curator of Botanic Gardens.	–	Implement	Ongoing	Ongoing	Ongoing	Ongoing

Milestone	Performance measure	Action officer/ partners	2019	2020	2021	2022	2023	2024
Compile and distribute a brochure providing guidelines to <i>T. ferdinandiana</i> harvesting and best practice management of populations.	Community awareness of the value of the species.	DENR/ Territory NRM)	–	–	Compile and distribute	–	–	–
Annually audit the progress of the management program against each of the performance indicators.	Brief annual statements suitable for public circulation.	Manager Wildlife Use DENR/DTSC/ NAAKPA	Annually	Annually	Annually	Annually	Annually	Annually
Review and update the management program by 2024.	Refinement of program that captures learnings and is supported by key stakeholders.	Manager Wildlife Use DENR/ NAAKPA /Industry sectors	–	–	–	–	Commence	Complete

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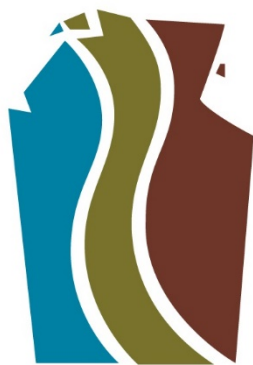
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