

DRAFT Management Program for ***Terminalia ferdinandiana***

In the Northern Territory of Australia, 2018-2022



native local food: sustainable use, livelihood opportunities

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

Parks and Wildlife Commission of the Northern Territory

Department of Environment and Natural Resources
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Front cover: *Terminalia ferdinandiana* by Julian Gorman

Executive Summary

The aim of this management program is to ensure wild populations of *Terminalia ferdinandiana* and its habitat are adequately maintained across the Northern Territory of Australia.

The objectives to achieve this aim are:

1. To promote the conservation of *T. ferdinandiana* through sustainable land management/harvest practice;
2. Promote sustainable practice among key stakeholders involved in the harvest and/or management of this species;
3. Identify strategic 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 mainly in the Kimberley and Northern Territory. It occurs in pockets of extremely high density around the coastal fringe and is a common part of the mid story of Eucalyptus 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 diversity of 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 both for subsistence and into the future for commercial purpose. The leaves and the fruit 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 3-8 metres in height, the fruit matures and ripens over a 2-4 week period and maturation is not synchronous between trees, overharvest is unlikely as 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 areas are managed through 'Take' permits so areas that are heavily harvested can be spelled if necessary if it were thought that they were suffering from inadequate recruitment or if there is an impact on other species. Increased human activity in the landscape can result in increased spread of weeds and on Aboriginal lands the Aboriginal Rangers are monitoring and dealing with this particular issue. It is likely that this activity, which encourages people to harvest from their Clan Estates, may result in early burning as the harvest occurs in April/May (the late wet season/early dry season).

Harvest permits are required for commercial harvests on all land in the NT (Aboriginal, Crown and Private). Therefore any major increases in harvest would be noticed and could trigger monitoring of Crown Land to ensure trees are not getting damaged during harvest and weeds are not increasing. These factors are already being monitored on Aboriginal land where commercial harvesting is occurring.

The NTG encourages a strategy of conservation through the sustainable use of wildlife (PWCNT 1997) and this management plan strongly endorses this strategy as it allows for livelihood benefits from country which in turn encourages better land management.

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1. Introduction

Terminalia ferdinandiana Exel. 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. Over this large 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 of 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/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). There is literature from the 1980s (Brand et al. 1982) which describe the high Vitamin C content of the fruit. Both NT and WA Agriculture departments have in the past released Agnotes promoting it as a horticultural potential. There has been limited horticulture of this species, but despite its commercial potential and increasing demand there has been limited progress and many knowledge gaps remain. 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). There are concerns around sustainability of wild harvest (e.g. damage to trees and competition with native fauna for fruit), with growing market demand for Kakadu Plum fruit. Increased demand stems from scientific evidence that both fruit and leaf have high concentrations of natural compounds of commercial interest with food preservative, pharmaceutical and nutraceutical applications. 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 creates and species that depend on it for food and shelter.

1.1 Aim and objectives

The main aim of this management program is to:

*Ensure wild populations of *T. ferdinandiana* and its habitat are adequately maintained across the species' [historical](#) range in the Northern Territory (see Section 31(1) of TPWC Act 1977).*

The objectives to achieve this aim are:

- i) To promote the conservation of *T. ferdinandiana* through sustainable land management/harvest practice;
- ii) Allow for the sustainable use and promote sustainable practice among key stakeholders involved in the harvest and/or management of this species (see Section 31(1) e of TPWC Act 1977)
- iii) Identify strategic 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) To promote public awareness and education of the Northern Territory Government strategy for conservation through the sustainable use of wildlife (PWCNT 1997);

1.2 Species

Terminalia ferdinandiana Exell. is part of the Combretaceae family 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 of Western Australia (WA), 12 in Northern Territory (NT) and 16 in north Queensland (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, where it occurs across 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. l. 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 taxonomic work needs to be conducted in this area.

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

1.3 Responsible authority

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* (TWPC Act). The Northern Territory Government, through the Department of Environment and Natural Resource Management (DENR) and the Department of Tourism and Culture (DTC) administers the TWPC 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. DTC is responsible for Part IV Divisions 6 Permits including the issuance of research and commercial use permits. In the situation of an adopted formal management plan, DENR is responsible for overseeing the harvest allocation process and works with DTC to ensure appropriate permits are issued.

1.4 Legislative, national and international obligations

1.4.1 Northern Territory

Territory Parks and Wildlife Conservation Act (TPWC Act) 1999

Terminalia ferdinandiana is not listed as a threatened plant nor is it is 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 in this context 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*.

In addition to the requirements for permits for harvesting fruit/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 Section 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.

Under the *Pastoral Land Act* and *Crown Land Act*, a licence may be required to take plants or plant production for commercial purpose on Pastoral or Crown Lands.

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.

Terminalia 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) and/or *Convention on International Trade in Endangered Species of Wild Fauna and Flora* (CITES) listed specimen, 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. *Terminalia 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

Terminalia ferdinandiana is not listed under the CITES so there is no international legislation that should affect the export of processed *T. ferdinandiana* products. There are however, restrictions to 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/>).

2. Background information

Australia has a rich natural, floristic, resource base (+19,000 endemic vascular plant species) and the Northern Territory hosts many of these endemic plants in its landscape, which are

comparatively undisturbed and intact (Australian National Botanic Gardens, 2018; Cunningham et al. 2008). Utilisation of wildlife offers remote communities livelihood opportunities and in return provides these landscapes with a finer scale of natural and cultural resource management than they would receive otherwise.

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 (i.e. crocodiles; cycads; magpie geese)

Wildlife, and the use of, are very important to people (especially Aboriginal) 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; Nikolakis 2010). The NT Government has supported 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). Arguably the biggest threat to NT landscapes is the extremely low number of people on country (0.1 persons per square km), which inevitably results in a loss of cultural connection and activity and changes in land management, such as through increased wild fires and often feral animals and plants.

Terminalia ferdinandiana has exceptional properties and commercial demand 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 currently relatively economically unproductive and unpopulated tropical savannas. This economic base could help support Aboriginal people to maintain or retain connection with their traditional country, benefiting people and the environment.

Aboriginal owned land is over 52% of the NT, and the majority of the natural occurrence of *T. ferdinandiana* falls on Aboriginal tenured 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 there is no reason why this cannot be achieved in an ecologically sustainable manner. 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 Tharrurr 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.

2.1.1 Land tenure

Commercial use on Crown Land and Aboriginal tenured land are regulated slightly differently. Both required a Take Permit from the NTG which is concerned with sustainable use but on Aboriginal tenured land there are cultural protocols and additional legislation relating to access and authority. This is done through Section 19c of the *Aboriginal Land Rights (Northern Territory) Act 1976*, which ensures Traditional Owners authorise any commercial activity on their land; generally done through a Land Use Agreement. 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.

2.1.2 Economic values

There is a diversity of markets for *T. ferdinandiana* including nutritional, preservative, pharmaceutical, nutraceutical amongst others. In the 1990/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 health tablet produced by an American Company, Manatech. More recently the Prawn Industry has used an extract of it 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 (more than 2 m in height) has been recorded in excess of 500 trees/ hectare (ha), with the highest densities on or near the coast (Woods 1995). The coastal strip in the Darwin region was found to have mature trees (>2m in height) at 272±169 trees per ha (Whitehead et al. 2006). At intervals from the coast central Arnhem land to 50 km inland densities averaged 14.4± 24.3 trees/ha with the highest density being along the narrow coastal strip (82 trees/ha) and on clay soils 40 km inland (31 trees/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) making *T. ferdinandiana* very common. 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 and rainfall and disturbance (fire).

T. ferdinandiana has been found at its highest density along the coast of northern Australia in and between 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, around November it throws new leaves and very soon afterwards flowers. To be able to do this requires a store of food which is in lignotuber and /or in the trunk. This being the case it is likely that the production one year is dependant 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 have been seen to have a competitive edge over non-Eucalypts because of their ability to grow from 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 to size during a fire free interval. In the tropical savannas, especially in Eucalyptus woodlands, fires are often annual or biannual. Recruitment of non-Eucalypts like *T. ferdinandiana* require a 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 clustered fire regimes are probably different (less frequent and intense) allowing recruitment and a much different density and population demographics.

These environmental variables, especially fire regimes, make it difficult to define the distribution and density *T. ferdinandiana* with any accuracy. They are found in the tropical savannas as far south as Broome in WA appear to be most prolific in areas above 1000mm annual rainfall. They occur on a ranger of soils from the relatively well drained sandy loams that support Eucalypt woodland 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; no unique reflective signatures for *T. ferdinandiana* have been identified.

So in summary, although the general distribution of *T. ferdinandiana* is well known, factors effecting local distribution 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.

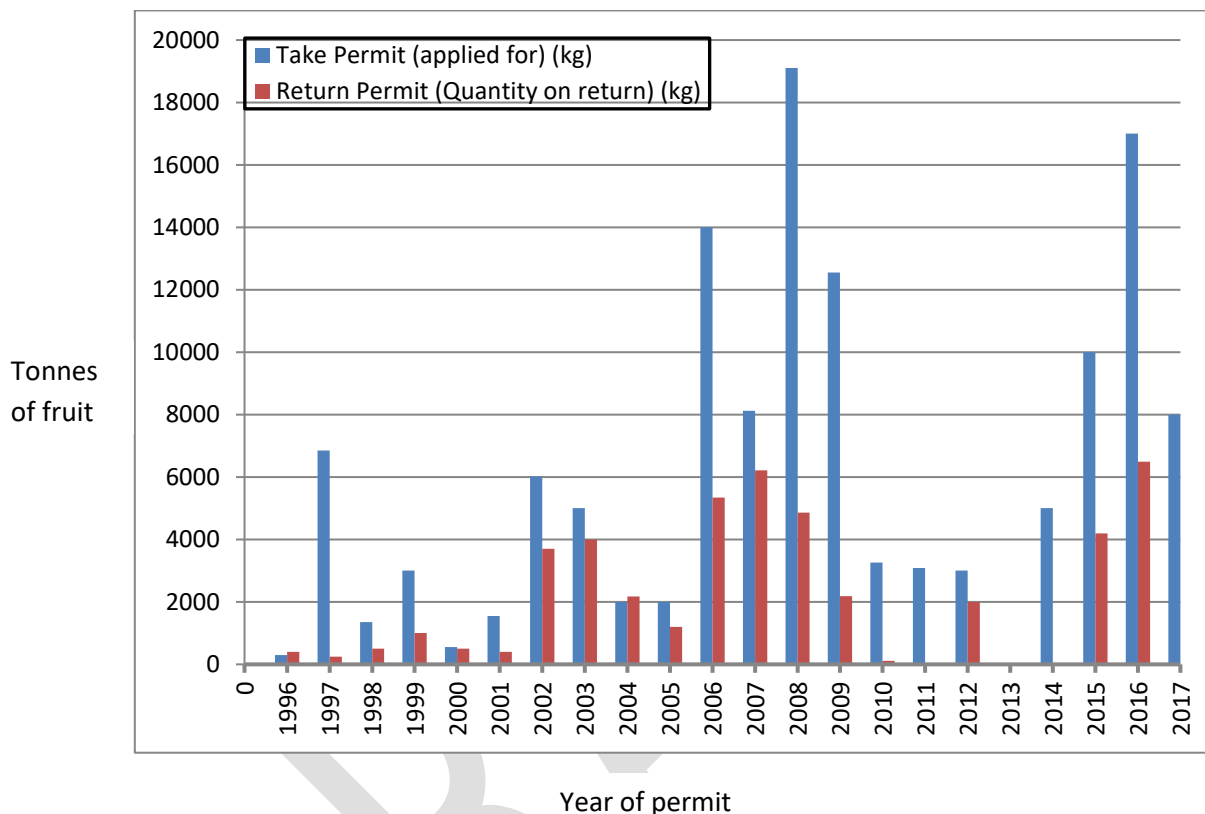
2.4.2 Commercial Use

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 reflected in the NTG permit system (see Figure 1). These permit requests pertain to 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 Return Permit which states how much fruit was actually collected. A royalty is paid on this amount if collected on Crown Land.

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

Figure 1: Cumulative NTG Parks and wildlife permits requests for commercial harvest of *Terminalia 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; an impact on recruitment; a reduced food source for native animals that rely on the fruit; spread of weeds and fire from increased human presence in bush.

3.1 Physical harm to tree

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 3 years 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. The literature shows that 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 NTG has records of where proponents have picked, so can check these areas and can take action if trees are being poorly treated by harvesters.

3.2. Impact on recruitment

T. ferdinandiana is a tree which grows to 6 metres in height and there is 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 Acid and Ellagic acids levels are at their peak; this is at the very end of the fruits maturation phase (growing phase), 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 indeed the fruit on different racemes may also be different ages. Therefore the fruit is not all ready to pick at the same time and therefore not all fruit on a tree is likely to be picked. Ticktin (2015, 2004) give examples and refer 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 an extremely low likelihood of impact on recruitment and at very worst this impact would 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. These would include possums, black-footed tree rats, red-tailed black cockatoos and others. A similar argument could be used as in 3.2. in that there would still be a large percentage of fruit left on the tree because it is less accessible to harvesters. Ripe fruit that animals are likely to target is different to the mature fruit that harvesters are targeting. Additionally harvesters target clumps of *T. ferdinandiana* trees and do not bother harvesting in low density due to reduced cost/benefit.

3.4 Spread of weeds and fire

With increased access to country by people harvesting fruit commercially there is a threat of unintentional spread of weeds. The pattern of weeds following human movement and disturbance is well documented. 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 (*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. Many would consider that the benefits of having people visiting country would counter the threats posed by increased spread of weeds.

4.0 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 regime, and surveillance for weeds and pests and continuation of traditional land management practices.

However to promote conservation of *T. ferdinandiana* into the future and to maximise potential economic benefit to the Northern Territory there are numerous knowledge gaps that should be investigated.

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 i.e. certain qualities will be desired by different markets. An understanding of the variability may facilitate economic opportunities with an ability to supply diverse markets. There may be also implications for management of the species if certain “varieties” are selectively harvested. A better understanding of taxonomy and variation will allow more precise management and 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 density of occurrence 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 recruitment will inform an understanding of these patterns and also assist in understanding the landscape wide management required for the conservation of the species.

4.2.1 Impacts of fire

An understanding of the role of fire in recruitment, particularly of fire intensity and fire frequency would allow land managers to implement a fire regime that favours the recruitment of *T. ferdinandiana*.

4.2.2 Soils moisture availability

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.

4.3 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 co-benefits. This will allow a better estimate of the economic and social 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 people need to travel?).

With predicted rise in market demand it is likely that cultivation will also be a component of the supply chain. To support the development of cultivation in a sustainable way 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 markets. There is also a requirement for research into the horticultural requirements of the species (e.g. fertilizer, irrigation, pest management).

4.4 Permit conditions

To inform the issuing of permits 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 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. In the absence of key information on which to base permit conditions on, a range of key management issues are presented in Box 1 for further public consultation.

Box 1 Key Management Issues:

1. What is an appropriate harvest ceiling to apply in the absence of detailed information on long-term yields and sustainable harvest limits?

The information available suggests that the risk of overharvest is relatively small. As a starting point harvests could be limited to trees over 2.5 m and no more than 80 % of the fruits be harvested in any year. Harvest could be also limited to only 2 years out of every 3 for specific trees.

2. How should the harvest be allocated at a landscape level?

Tree density and area to be harvested should be sufficient to provide a reliable harvest of at least 200 kg pa. No commercial harvest should occur on areas of high conservation significance. Individual communities should have the final say in appropriate locations for harvesting.

3. What data should be collected to inform review and revision of future management plans?

Consultation is required with Aboriginal groups regarding what data could be collected. Trees harvested could be recorded along with amount (weight) of harvested fruit.

4. What other issues need to be considered longer term to ensure sustainability and viability of a Terminalia industry that benefits local communities?

Issues of fire management and other habitat management as well as silvicultural requirements could be worthy of further studies. Such research should directly engage local communities where possible.

5. How can the key knowledge gaps identified in this plan be addressed and what that should be focussed on during the next 5 years?

A range of important research gaps are identified in Section 4 of this plan. Further input is sought as to whether this list is comprehensive, how these could be best addressed and potential funding opportunities, as well as which are the highest priorities to improve the long-term sustainability and economic benefits arising from use of the species.

4.5 Issues for further discussion

Further consultation is required to consider measures of ensuring sustainability of harvest before this Management Plan can be finalised. The following questions will be considered among others as part of this process.

Should:

- an overall harvest ceiling be set for the NT?
- there be a regional ceiling be set for spatial spread of harvest?
- there be a review of harvest to refine allowable take on year to year basis?
- there be a 1 in every 4 year harvest exclusion of areas to allow for recruitment?

Once these issues have been discussed and decided on the Draft Plan will be put out for public comment and subsequently submitted for approval by the NT Minister Environment.

DRAFT

5.0 References

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