

Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act)
Approved Conservation Advice for the
Monsoon vine thickets on the coastal sand dunes of Dampier Peninsula

1. The Threatened Species Scientific Committee (the Committee) was established under the EPBC Act and has obligations to present advice to the Minister for Sustainability, Environment, Water, Population and Communities (the Minister) in relation to the listing and conservation of threatened ecological communities, including under sections 189, 194N and 266B of the EPBC Act.
2. The Committee provided its advice on the Monsoon vine thickets on the coastal sand dunes of Dampier Peninsula ecological community to the Minister as a draft of this approved conservation advice. In 2013, the Minister accepted the Committee's advice, adopting it as the approved conservation advice.
3. The Minister amended the list of threatened ecological communities under section 184 of the EPBC Act to include the Monsoon vine thickets on the coastal sand dunes of Dampier Peninsula ecological community in the endangered category. It is noted that the ecological community is also listed as the Monsoon vine thickets on the coastal sand dunes of Dampier Peninsula on the Western Australian list of threatened ecological communities endorsed by the Western Australia Minister for the Environment.
4. The nomination and a draft description for this ecological community were made available for expert and public comment for a minimum of 30 business days. The Committee and Minister had regard to all public and expert comment that was relevant to the consideration of the ecological community.
5. This approved conservation advice has been developed based on the best available information at the time it was approved; this includes scientific literature, advice from consultations, existing plans, records or management prescriptions for this ecological community.

Table of Contents

Description	4
Name of the ecological community	4
Location and Physical environment	4
Climate	5
Vegetation	8
Fauna	9
Key diagnostic characteristics and condition thresholds	11
Surrounding environment and landscape context	14
Area critical to the survival of the ecological community	14
Geographic extent and patch distribution	15
National context and existing protection	15
Summary of threats	16
Summary of eligibility for listing against EPBC Act criteria	17
Priority Research and Conservation Actions	19
Research priorities	19
Priority recovery and threat abatement actions	19
Existing plans/management prescriptions	21
Recovery plan recommendation	21
Appendices	22
Appendix A - Distribution map	22
Appendix B - Species lists	23
B1. Characteristic plant species	23
B2. Rare plant species	29
B3. Fauna	30
B4. Weed species	34
Appendix C - Detailed description of biology and ecological processes	35
Vegetation dynamics	35
Faunal roles and interactions	35
Hydrology	36
Role of fire	37
Appendix D - Detailed description of national context and existing protection	38
Heritage	38
Relationships to State-listed ecological communities	38
Relationships to other vegetation classifications	38
Differences to similar or intergrading ecological communities	38
Level of protection in reserves	39

Appendix E - Description of threats	40
Clearing/fragmentation/disturbance	40
Inappropriate fire regimes	40
Invasive species.....	41
Altered hydrology	43
Climate change.....	43
Key threatening processes.....	44
Appendix F - Eligibility for listing against the EPBC Act criteria	45
Bibliography.....	52

Description

Name of the ecological community

This advice follows the assessment of information provided by a public nomination to list the Monsoon vine thickets on the coastal sand dunes of Dampier Peninsula as a threatened ecological community under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The name reflects that this vegetation type is mainly confined to dunes and other Holocene¹ coastal landforms of the Dampier Peninsula and heavily dependent on wet (monsoon) season rainfall.

Most common names used in this document have been obtained from available flora and fauna reference sources. However, it is recognised that Indigenous people of the Dampier Peninsula have particular names for plant and animal species and these have also been used for certain species.

Location and physical environment

The Monsoon vine thickets on the coastal sand dunes of Dampier Peninsula ecological community (hereafter referred to as the Dampier Monsoon Vine Thickets or the ecological community) represents certain occurrences of monsoon vine thickets in the southwest Kimberley region of Western Australia (within the Dampierland bioregion). The ecological community is predominantly restricted to the coastlines of the Dampier Peninsula from Broome in the south to One Arm Point in the north and on the northeastern coast of the Peninsula from One Arm Point to Goodenough Bay. The ecological community represents the most southern occurrences of rainforest type vegetation in Western Australia. The extent of the ecological community corresponds to country (the traditional lands) of the Bardi Jawi, Djabera Djabera, Goolarabaloo, Jabirr Jabirr, Nyul Nyul and Yawuru Indigenous people and the ecological community is of cultural significance.

The Dampier Monsoon Vine Thickets occurs in the south-west Kimberley region of Western Australia. The distribution of the ecological community lies within the Dampierland bioregion (subregion DL2–Pindanland) (Interim Biogeographic Regionalisation for Australia — IBRA V7). The ecological community wholly occurs in the Kimberley subregion of the Rangelands Natural Resource Management region.

The Dampier Peninsula is bounded by the Indian Ocean on the west coast, King Sound on the east coast and the Great Sandy Desert to the south. The Dampier Peninsula has a low gradient, which gradually rises to a maximum elevation of 247m above sea level (asl) at approximately 60 km northeast of Broome. Due to the low elevation, seasonal runoff tends to form sheets, with water pooling in areas behind the coastal dune system.

The upper soil profiles of the Dampier Peninsula are predominantly comprised of extensive red pindan² sandplains of mixed river-deposited and wind-blown sediments, which formed during the Quaternary³ period on desert dune sandstone. The uniform clayish sands, ranging from red to yellow-grey, form extensive undulating plains with little or no surface drainage. In some areas, such as near Broome, the pindan soil is overlain by more geologically recent unconsolidated sand.

¹ The Holocene epoch started approximately 12 000 years BP (before present day) following the last glacial period.

² Pindan refers to the geology and vegetation that forms the transitional zone between the wetter monsoon forests of the north Kimberley and the Great Sandy Desert to the southeast, exhibiting a mix of monsoonal and arid species.

³ The Quaternary period commenced approximately 2.6 million years BP. It includes the Holocene epoch and the preceding Pleistocene epoch.

The interior plains of the Dampier Peninsula are dominated by pindan, a woodland of mainly eucalypts and a varying middle layer of acacias (Kenneally et al., 1991; Barrett, pers. comm., 2012). Coastal areas also contain samphire flats, mangroves, paperbark thickets and monsoon vine thickets (Kenneally et al., 1991).

The coastal dune environment, being largely of sand, has minimal soil development and is susceptible to erosion from various sources including rising tides, strong winds and cyclonic activity. Tides of the Dampier Peninsula range up to 11 m and are a major factor affecting the coastal environment where the ecological community occurs.

The Dampier Monsoon Vine Thickets is particularly associated with Holocene sand dunes and other coastal geological formations (Black et al., 2010). The Holocene sand dunes are typically stable, however, a few are active and encroach inland (Kenneally et al., 1996). The Holocene sand dunes typically have deep white (but may range through to pink) or grey calcareous coastal sands, often containing marine shells. Most patches of the ecological community occupy the leeward slopes and swales and sometimes the exposed crests. Some patches may extend landward onto the red-soil pindan plains.

Climate

The Dampier Peninsula is located between the Great Sandy Desert to the south and the monsoonal tropics to the north. It has a tropical climate with distinct wet and dry seasons and varies between hot, and very dry, to hot, and very wet.

The ecological community's area of occupation is closely associated with the Holocene dunes on the Dampier Peninsula coast with the southern-most limit of patches occurring close to the 600 mm isohyet near Broome. The arid limit of rainforest is generally restricted by this precipitation gradient (Webb and Tracey, 1981; Russell-Smith, 1991; Bowman, 2000). Patches may occur on similar sandy substrates, such as pindan, if sufficient moisture is present.

Although the wet season commences in October, the majority of annual rainfall on the Dampier Peninsula typically occurs from December to March. Annual median rainfall for the Peninsula occurs from up to 718 mm per year in the north (Cape Leveque) to 532 mm per year in the south (Broome) with yearly variation ranging from 20% to 40%. The dry season commences in April.

Daytime temperatures are consistently high throughout the year. However, there is variation between wet and dry seasons (Table 1). During the early dry season, cooler overnight temperatures occur. Heavy fogs can occur along the Dampier Peninsula coast during the dry season, especially in the southern range of the ecological community (Kenneally et al., 1991; BOM, 2011).

Table 1: Temperature variation for the Dampier Peninsula (BOM, 2012).

Location	Season	Min Av. temp range °C	Max av. temp range °C
Broome (South)	Dry	15–18	30–33
	Wet	24–27	33–36
Cygnet Bay (North)	Dry	18–21	33–36
	Wet	24–27	33–36

Indigenous people of the region recognise six seasonal differences throughout the year that are associated with marine and terrestrial resources (Kenneally et al., 1996). The seasons for three Indigenous groups are shown in Table 2, some of which overlap:

Table 2: Indigenous seasons for the Dampier Peninsula (McKenzie et al., 1991; Kenneally et al., 1996; Goolarabooloo, 2011; Yawuru, 2011).

	January	February	March	April	May	June	July	August	September	October	November	December
Group												
Yawuru	Man-gala The WET. Strong northwest winds. Plants grow fast. Ngaliwany (<i>Persoonia falcata</i>) and gabiny (<i>Terminalia ferdinandiana</i>) fruiting. Reef fish are fat. Turtles lay eggs. Barn swallows and swifts flying, insects abundant, snakes and lizards are out			Marrul Changing season. Little wind or rain, Humidity drops. Large tides, reef fish & shellfish are skinny Lizards are fat. Lots of mayi (bushfruit). Tadpoles become frogs; Puddles dry up.		Wirralb-uru Cooling Season. SE winds start. Lizards hibernate.	Barrgana Cold Season. Strong dry SE winds and dust storms. Whales start arriving. Walga-walga (blunose salmon) gurlban (mullet) and nganarr (dugong) are fat. Jiribuga (echidna), langgurr (possum) and barrjarniny (agile wallaby) are fat. Lizards hibernate. Ngamagarr (little corella) eggs hatch. Jigal tree flowering, sweet nectar.		Wirburu Warming up season. Westerly winds start. Birds feed on yarrinyarri (<i>Cyperus bulbosus</i>). Lizards (skinny) emerge from hibernation. Acacia bear seedpods.	Laja Hot time. Build up to wet season. Birndany (stingray) reef fish & shellfish are fat. Turtles are mating. Yaminyarri; gubiny and gunurru (<i>Corymbia flavescens</i>) flower. Seeds & pods are collected for drying & roasting. Ngaliwany fruiting.		Man-gala
Goolarabooloo	Mankala Storms. Plants growth is rapid. Yarrinyarri (<i>Cyperus bulbosus</i>) shoots. Gubinge (<i>Terminalia ferdinandiana</i>) fruiting. Insects are abundant. Pools are full of tadpoles. Nimanburr (flying fox) in large groups. Snakes are everywhere; lizards are too skinny to hunt.			Marul Weather hot and humidity high. Rains stop soon. Lizards are fat. Carpet snake have their young. Tadpoles become frogs. Birds feed on minmin nectar (<i>Crotalaria cunninghamii</i>).		Wirralburu SE winds start. Waterholes drying up. Yarrinyarri are dug up and eaten. Sandpaper fig (<i>Ficus</i> spp.) fruit abundant. Reef fish are skinny. Lizards still fat and start to dig their holes.	Barrgana Cold time. Whales are migrating north. Southeast winds blow strongly and sometimes occasional light rain. Small duststorms. Lizards hibernate. Yarrinyarri are plentiful, conkerberry (<i>Carissa spinarum</i>) fruiting, jigal trees (<i>Bauhinia cunninghamii</i>) are flowering.		Wilburu The weather starts to warm. Low spring tides good for reef walking to get bream, sea perch and snapper. Shellfish are fat and mangrove crabs.	Larja Hot time, the air is humid, building up to the wet. Moonga (native honey) available in jigal. Gubinge and gumamu (<i>Santalum lanceolatum</i>) in flower. Stingrays are fat. Reef fish and shell fish are fat Mating time for turtles.		Mankala

	January	February	March	April	May	June	July	August	September	October	November	December
Group												
Bardi	<p>Mankal</p> <p>Wet season. Strong winds and storms from the ocean.</p> <p>Little fruit except gamooloon (<i>Persoonia falcata</i>).</p>	<p>Ngalandany</p> <p>Season of no fruit.</p> <p>High temperature and humidity, little wind.</p>	<p>Iralboo</p> <p>King tides, ideal for reefing.</p> <p>Much available fruit including iidool (<i>Pandanus spiralis</i>).</p> <p>Goannas, caterpillars, grasshoppers & kangaroos are fat.</p> <p>When the biilarl (<i>Corymbia greeniana</i>) flower, dugong hunting season begins. Southeast winds begin towards April.</p>	<p>Barrgana</p> <p>Cold season. Southeast winds blow.</p> <p>Gaamba (nuts) of iidool are red and indicate it is dugong hunting season.</p> <p>Many fish are fat. Not good tides for reefing.</p> <p>Many resources available including honey, snakes, wallaby, lizards and fruits including joongoon (<i>Mimusops elengi</i>).</p>	<p>Jalalay</p> <p>Short warming up season. Dugong season ends.</p> <p>Low spring tides good for reefing.</p> <p>Garnboor (<i>Melaleuca dealbata</i>) flowers indicate the stingrays are fat.</p>	<p>Lalin</p> <p>Build up to the wet, hot and humid.</p> <p>"Married turtle time" and turtle hunting season. Iilarr (<i>Syzygium eucalyptoides</i>) available.</p> <p>Winds shift from westerly to strong northwest bringing the rain.</p>	<p>Mankal</p>					

Vegetation

The Dampier Monsoon Vine Thickets occurs as discontinuous patches of dense vegetation and contains approximately 23% of vascular plant species that occur on the Dampier Peninsula (Black et al., 2010). The degree of the ecological community's fragmentation reflects the natural distribution and influences from the surrounding environment. The patches are usually located within the swales on the leeward side of the coastal Holocene dune systems. Patches tend to be larger with increasing dune size (Kenneally et al., 1996; Harding et al., 2009). Outliers may occur on different substrates where other factors, such as moisture availability, support the ecological community (Black et al., 2010; Tim Willing pers. comm., 2011). In the absence of fire, the ecological community can often form a continuous link with adjacent fire-prone communities (Russell Barrett, pers. comm., 2012).

Dampier Monsoon Vine Thickets are considered a rainforest subset ranging from semi-deciduous vine thickets to closed semi-deciduous vine forest. The ecological community contains deciduous, semi-deciduous and evergreen perennial flora species. Patches in the higher rainfall zone (e.g. Cape Borda and Cape Leveque) tend to be the most species rich and can extend onto pindan soils, particularly in the lee of dunes. These patches tend to have a much more dense canopy and be characterised by co-dominant evergreen tree species in the overstorey. The ground layer is often sparse or absent. Patches of the ecological community in the lower rainfall zone, as well as those generally situated on low dunes and other exposed locations, are mostly depauperate in evergreen trees and have a more open canopy and shrubby structure.

The ecological community provides an important habitat for a number of plant species. For example, the vine *Parsonsia kimberleyensis* is at the southern-most limit of its range within the ecological community along with *Glycosmis* sp. and the deciduous shrub *Croton habrophyllus* (Kenneally et al., 1996). The small tree, *Vitex glabrata* (bush currant) is only known to occur on the Dampier Peninsula in the ecological community (Black et al., 2010).

The Dampier Monsoon Vine Thickets shares species with some adjacent ecological communities that it intergrades with. For example, *Acacia* spp. are common in the ecological community and the adjacent pindan. The related transition zones also provide habitat for restricted species such as the Kimberley endemic shrub *Helicteres rhynchocarpa*. In addition the southern-most range of the shrub *Trophis scandens* corresponds with habitat adjacent to the Dampier Monsoon Vine Thickets (Black et al., 2010).

The Dampier Monsoon Vine Thickets has an abundance of fruiting plants and these are dependent on the movement of frugivorous animals between patches for seed dispersal, maintaining essential plant species migration and gene flow. Tree and shrub species that are dependent on this type of dispersal include *Diospyros humilis* (ebony wood), *Exocarpos latifolius* (mistletoe tree), *Ficus virens* (banyan fig), *Flueggea virosa* subsp. *melanthesoides* (snowball bush), *Mallotus nesophilus* (yellow ball flower), *Mimusops elengi* (mamajen), *Sersalisia sericea* (formerly *Pouteria sericea*) (mangarr) and *Terminalia petiolaris* (marool/nawulu or blackberry tree) (Kenneally et al., 1996).

Canopy layer (overstorey) – trees and vines

The canopy of the ecological community is typically dominated by a mix of several tree or tall shrub species which, depending on the landscape position and microclimate, may be deciduous, semi-deciduous or evergreen (Appendix B, Table B1). A patch can be occasionally dominated by a single tree species such as ebony wood or *Celtis philippensis* (goolnji).

The canopy height of the ecological community typically ranges from three metres in exposed beach and headland positions, up to nine metres where large sand dunes provide more sheltered valleys on the swale or lee side. Emergent tree species may extend beyond the canopy.

Typical overstorey trees include: goolnji, ebony wood, mamajen, mangarr, *Terminalia ferdinandiana* (gabiny/gubinge/kabiny) and blackberry tree/marool/ nawulu. The species composition of the tree canopy can be variable and may also include genera such as *Acacia*, *Corymbia*, *Eucalyptus*, *Hakea* and *Melaleuca* (Black et al., 2010). Many of the individual canopy species are more widespread and have ranges that extend outside the Dampier Peninsula.

Mid layer (understorey) – medium to tall shrubs and low trees

The mid layer, when present, can contain scattered semi-deciduous fruiting shrubs and small trees. Typical plant species present in the mid layer of the Dampier Monsoon Vine Thickets include: *Breynia cernua*, *Bridelia tomentosa*, *Croton habrophyllus*, *Dodonaea platyptera* (broad-winged hop bush), *Exocarpos latifolius* (mistletoe tree), snowball bush, *Pandanus spiralis* (common screwpine), and *Santalum lanceolatum* (tropical sandalwood).

Vines

Vines/climber species can be present in all layers of the ecological community. While vines are not the dominant component of the ecological community, they typically comprise up to 25% of the native perennial plant species richness in it. Vine species mainly occur with other tree and shrub species and are often inconspicuous, particularly during the dry season when they are leafless or die back to rootstocks. Common vines/climbers include: *Abrus precatorius* (crab's eye bean), *Adenia heterophylla*, *Caesalpinia major*, *Capparis lasiantha* (bush caper), *Jacquemontia paniculata*, *Jasminum didymum*, *Tinospora smilacina* (snake vine) and *Tylophora cinerascens* (formerly *Marsdenia cinerascens*) (oyster-catcher bill).

Ground Layer

The ground layer of the Dampier Monsoon Vine Thickets is generally shaded and often with a layer of leaf litter or dark organic matter of up to six centimetres in depth on the soil surface. Where the canopy is mostly intact, the ground layer is usually very sparse. Canopy shading combined with dense leaf litter, generally prevents annual grasses from establishing. Patches with closed canopies lack native grass or fern species in their interiors. Annuals are mainly absent in closed canopy patches particularly during the dry season. Where the canopy is more open, annuals may occur during the wet season (Appendix B, Table B1).

Fauna

Compared to the adjacent open vegetation occurring over the majority of the Dampier Peninsula, the relatively dense, closed canopy of the Dampier Monsoon Vine Thickets provides a shady and humid microclimate. This relatively moist environment provides refuge for animals particularly during the dry season when fires in the landscape are more frequent (Johnstone and Burbidge, 1991; Kendrick and Rolf, 1991; Price, 2004). The abundance of fruiting plants within the ecological community also provides relatively rich food resources for many taxa. No fauna are known to be endemic to the ecological community on a national scale, but some species are endemic at a regional level and many species occur both in the ecological community and surrounding vegetation types. The following description identifies fauna that have been recorded in, and/or are known to utilise, the ecological community.

Birds recorded in the ecological community include *Aprosmictus erythropterus* (red-winged parrot), *Coracina novaehollandiae* (black-faced cuckoo-shrike), *Geopelia humeralis* (bar-shouldered dove), *Myiagra ruficollis* (broad-billed flycatcher), *Pachycephala melanura* (mangrove golden whistler), *Ptilinopus regina* (rose-crowned fruit-dove; red-crowned pigeon), *Ptilonorhynchus nuchalis* (great bowerbird), *Scythrops novaehollandiae* (channel-billed cuckoo), as well as dollar birds and honeyeaters (Johnston and Johnstone, 1983; Burbidge, 1991; Kenneally et al., 1996; Environs Kimberley, 2009; Biota Environmental Services, 2010b;

Black et al., 2010). In Western Australia, the frugivorous rose-crowned fruit-dove is at its southern most limit on the Dampier Peninsula and in this location it is restricted to the ecological community (Johnstone, 1983; Black et al., 2010).

The Dampier Monsoon Vine Thickets is characterised by a large number of bats, both micro-chiropteran (insectivorous) and mega-chiropteran (frugivorous), and frugivorous birds (McKenzie, 1991; Black et al., 2010). Many of these species are associated with fruiting plants within the ecological community. Species recorded in the ecological community include *Chalinolobus gouldii* (Gould's wattled bat), *Chalinolobus nigrogriseus* (hoary wattled bat), *Nyctophilus arnhemensis* (Arnhem long-eared bat) and *Scotorepens greyii* (little broad-nosed bat) (Biota Environmental Services, 2010). Additionally more than 15 species of bats have been recorded within vegetation adjacent to the ecological community (McKenzie, 1991). Given that bats are typically seasonal in their use of complementary (surrounding) habitats it is likely there is a seasonal reliance on the ecological community for food, particularly for frugivorous bats such as *Pteropus alecto* (black flying fox) (Kenneally et al., 1996; Palmer et al., 2000).

Other mammals recorded in the Dampier Monsoon Vine Thickets include *Macropus agilis* (agile wallaby), *Pseudomys delicatulus* (delicate mouse) and *Nyctophilus arnhemensis* (Arnhem long-eared bat) (McKenzie, 1991; Biota Environmental Services, 2010). Species such as *Hydromys chrysogaster* (water rat) and *Trichosurus vulpecula* (northern brush-tailed possum) are highly likely to utilise vine thickets for habitat and foraging. Other species that have been recorded on the Dampier Peninsula that have the potential to periodically use vine thickets for habitat or refuge include: *Canis lupus dingo* (dingo), *Macrotis lagotis* (bilby, dalgyte), *Petaurus breviceps* (sugar glider, bollanga), *Planigale maculata* (northern planigale) and *Pseudomys nanus* (western chestnut mouse).

Reptiles recorded in the ecological community include *Ctenotus inornatus*, *Eremiascincus isolepis* and *Lerista bipes*. Although these reptiles are known to occur in many other vegetation types, they are characteristic fauna species within some vine thicket patches. The endemic *Simoselaps minimus* (Dampierland burrowing snake) also occurs in the ecological community and possibly in the sandy junction between the dunes and adjacent pindan. It is likely that this species preys on skinks from the *Lerista* genus. Detailed investigation of amphibians within the ecological community has not occurred, but *Platyplectrum ornatus* (ornate burrowing frog) has been recorded within the Dampier Monsoon Vine Thickets (Biota Environmental Services, 2010).

While there has been limited assessment of the richness of all invertebrate fauna within the ecological community, invertebrates are diverse across the region (Johnstone and Burbidge, 1991; McKenzie and Dyne, 1991; Naumann et al., 1991; Solem, 1991). For example, within the Dampier Monsoon Vine Thickets, Fisher et al. (in prep) recorded approximately 70 species of ants from the following subfamilies: Myrmicinae, Dolichoderinae, Formicinae, Ponerinae, Ectatomminae, Cerapachyinae and Pseudomyrmecinae. Characteristic species include *Oecophylla smaragdina* (green tree ant). There is also a high diversity of land snails recorded from Kimberley vine thickets, such as *Eremopeas interioris* (outback awl snail), *Gastrocopta pediculus* (syn. *G. simplex*; weakly toothed pupas snail), *Nesopupa scotti* (syn. *Pupa mooreana*; blunt golden pupas snail), *Pupisoma orcula* (oriental toothless pupas snail) and *Quistrachia leptogramma* (McKenzie et al., 1991).

A broader list of fauna species recorded or likely to occur in the Dampier Monsoon Vine Thickets is in Appendix B, Table B3.

Key diagnostic characteristics and condition thresholds

National listing focuses legal protection on remaining patches of the ecological community that are most functional, relatively natural (see ‘Description’) and in relatively good condition. Key diagnostic characteristics and condition thresholds assist in identifying a patch of the threatened ecological community and when the EPBC Act is likely to apply to the ecological community. They provide guidance for when a patch of a threatened ecological community retains sufficient conservation values to be considered as a Matter of National Environmental Significance, as defined under the EPBC Act. This means that the referral, assessment and compliance provisions of the EPBC Act are focussed on the most valuable elements of Australia’s natural environment, while heavily degraded patches will be largely excluded.

Although significantly degraded or modified patches are not protected as the ecological community listed under the EPBC Act, it is recognised that patches that do not meet the condition thresholds may still retain important natural values. Therefore, these patches should not be excluded from recovery and other management actions (also see ‘Surrounding environmental and national context’).

Plant surveys conducted during the wet season will more easily identify the ecological community. However, accessibility is likely to be restricted due to weather conditions. Therefore, the Key Diagnostic Characteristics and Condition Thresholds are designed to identify the ecological community throughout the year.

The national ecological community is limited to patches that meet the following key diagnostic characteristics and condition thresholds:

Step 1 Key diagnostic characteristics

The key diagnostic characteristics for the Dampier Monsoon Vine Thickets are as follows:

- Distribution occurs within the Dampierland bioregion – mostly in the Pindanland subregion DL2 (IBRA⁴).
- The ecological community is mainly restricted to the deep white or grey calcareous sands of the coastal Holocene dunes of the Dampier Peninsula.
- The ecological community mainly occurs within the swales and on the leeward side of the coastal dunes and occasionally on the crests of these dunes and other coastal landforms such as: beach fronts, sand-spit headlands and storm ridges with intertidal flats (Black et al., 2010).
- Outliers may occur on different substrates within the DL2 subregion e.g. on pindan soil the ecological community may establish following dispersal of key species by frugivores and where these patches are buffered from moisture loss and fire.
- The overstorey (canopy) typically shows the following features:
 - The overstorey typically ranges from three to nine metres tall and may consist of trees, tall shrubs and/or climbers/vines.
 - The tree canopy composition is variable but the most common species are typically one or more of the taxa *Bauhinia cunninghammi* (jigal, joomoo), *Celtis philippensis* (goolnji), *Diospyros humilis* (ebony wood), *Exocarpos latifolius* (jarnba, mistletoe tree), *Grewia breviflora* (goolmi, currant/coffee fruit), *Mallotus nesophilus* (yellow ball flower), *Mimusops elengi* (joongoon, mamajen), *Sersalisia sericea* (mangarr), *Terminalia ferdinandiana* (gabiny, gubinge, kabiny) and *Terminalia petiolaris* (blackberry tree, marool, narwulu).

⁴ IBRA: Interim Biogeographic Regionalisation for Australia V7

- The understorey shows the following features:
 - Shrub and small tree species when present include: *Breynia cernua*, *Bridelia tomentosa*, *Caesalpinia major* (goolyi), *Croton habrophyllus* (ankoolmarr), *Dodonaea platyptera*, snowball bush and *Santalum lanceolatum*.
 - The ground layer is generally sparse to absent but may contain a variety of herbaceous species depending on seasonal conditions, site characteristics and canopy density.
 - Native grass species are uncommon but may occur on the edges of vine thicket patches or in open groves. When present they typically include annual species (Appendix B, Table B1) such as *Perotis rara* (comet grass) and *Setaria apiculata* (pigeon grass).
- Vines and creepers are often, but not always, present in the overstorey and/or understorey and when present include the following: crab's eye bean, *Adenia heterophylla* subsp. *australis*, *Capparis lasiantha* (ngoorla, bush caper), *Jacquemontia paniculata*, *Jasminum didymum*, *Tinospora smilacina* (oondal, snake vine) and *Tylophora cinerascens* (oyster-catcher bill).
- The following genera/species often present in other rainforest/vine thicket types in northern Australia, are typically absent or uncommon in the ecological community: *Albizia lebbek*, *Bombax ceiba*, *Cryptocarya cunninghamii*, *Elaeodendron melanocarpum*, *Ganophyllum falcatum*, *Vitex acuminata* and *Ziziphus quadrilocularis*. The understorey of other northern vine thicket patches also contain shrub species that are absent from the ecological community, such as those from the genera *Alectryon*, *Denhamia*, *Micromelum*, *Murraya*, *Strychnos*, *Trema* and *Wrightia*.

Step 2 Condition thresholds

The national ecological community comprises those patches that meet the key diagnostic characteristics and the following condition thresholds.

Native vegetation cover:

Canopy Layer

- 50% or more of the total cover of the canopy comprises perennial native species.

Understorey

- 50% or more of the total vegetation cover⁵ in the ground and mid layers comprises perennial native species.

Survey Considerations

Landuse history will influence the state in which a patch of the ecological community is expressed. The surrounding vegetation will also influence how important a patch of the ecological community is in the broader landscape.

Defining a Patch

A patch is defined as a discrete and continuous area of the ecological community. However, a patch may include small-scale disturbances, such as tracks or breaks, watercourses or small-scale variations in vegetation that do not significantly alter its overall functionality (functionality here refers to processes such as the movement of wildlife and pollinators, the dispersal of plant propagules, activities of seed and plant predators and many others).

Buffer zone

To assist in the preservation of the patch, it is recommended that a buffer zone be maintained from the outer edge of the patch. It is recommended that a buffer zone of at least 50 m from the

⁵ Total vegetation cover includes all vascular plants but **not** mosses, lichens, liverworts, plant litter or bare ground.

edge of the canopy cover be applied to the Dampier Monsoon Vine Thickets. The purpose of the buffer zone is to protect and manage the patch and to help avoid potential significant impacts to the ecological community. The buffer zone will help protect the patch edges and the ecological community from weed impacts and take into consideration appropriate fire management. Changes in land-use within the buffer zone must not have a significant impact on the ecological community, but there are exemptions for continuing use.

Revegetated areas

Revegetated or replanted sites are not excluded from the listed ecological community so long as the patch meets the key diagnostic characteristics and condition thresholds above.

Timing of surveys

The season of surveys is important because the ecological community can be variable in its appearance throughout the year and between years depending on hydrological inputs e.g. precipitation. Assessment should occur at a time of year where the greatest number of species is likely to be detectable. The edge of the patch can vary in appearance after a hot fire. It is important to note what kind of disturbance may have happened within a patch and when that disturbance occurred, as far as possible. Timing of surveys should also consider the detectability of flora species at different times of their life cycle, or their recovery after recent disturbances (natural or human-induced) to the ecological community.

Sampling protocols

Patches can vary in size and species makeup. The recommended sampling protocol involves developing a quick/simple map of the vegetation, landscape qualities and management history (where possible) of the site. The site should be representatively sampled for vegetation cover.

Surrounding environment and landscape context

In the context of actions that may have ‘significant impacts’ and require approval under the EPBC Act, it is important to consider the habitats that surround patches that meet the condition thresholds. The condition thresholds outlined above are the minimum level at which patches are to be considered under the EPBC Act for actions that may require approval. These thresholds do not represent the ideal state of the ecological community. Patches that are larger, more species rich and less disturbed may provide greater biodiversity value. Additionally, patches that are spatially linked, whether ecologically or by proximity, are particularly important as wildlife habitat and to the viability of those patches of the ecological community into the future.

Connectivity between remnants of the ecological community and with other native vegetation remnants is an important determinant of habitat quality at the landscape scale for native flora and fauna, as well as the overall condition of the ecological community. For flora, connectivity varies with the species in question. Generally it is important as it increases pollination and spread of propagules among individuals and populations. In addition, the diversity and abundance of fauna may depend on connectivity of a patch of the ecological community to other remnant vegetation.

In contrast, other patches that meet the condition thresholds occur in isolation and require protection or priority actions to link them with other patches. Other patches that are interconnected to similar native vegetation associations that may not, in their current state, meet the condition thresholds have additional conservation value. Therefore, the following indicators should be considered when assessing the impacts of actions or proposed actions under the EPBC Act, or when considering recovery, management and funding priorities for a particular patch:

- Evidence of recruitment of key native species or the presence of a range of age cohorts;
- Good faunal habitat as indicated by patches containing fruiting species, cover, refuge, contribution to movement corridors;
- Species richness, as shown by the variety and proportion of native flora and the diversity of fauna species present;
- Presence of listed threatened species;
- Areas of minimal weeds and feral animals, or where these can be managed easily; and/or,
- Patches that are in areas where the ecological community has been heavily degraded, or that are at the natural edge of its range, or local species assemblages that are representative of unique variants of the ecological community.

Area critical to the survival of the ecological community

Areas that meet the key diagnostic characteristics and condition thresholds plus the buffer zone are considered critical to the survival of Dampier Monsoon Vine Thickets. Additional areas such as adjoining native vegetation or areas that meet the description of the ecological community but not the condition thresholds are also considered important to the survival of the ecological community.

Individual patches and patch groups operate as an ecological network, with bird and mammal frugivore species playing key roles in connectivity (Black et al., 2010). Trees, shrubs and vines that produce copious amounts of fruit are important to the viability of the ecological community. Black et al. (2010) recommend the protection of all *Canarium australianum* (jalgir), *Ficus virens* trees (albay, banyan or strangler fig), hybrids of *Terminalia ferdinandiana* x *petiolaris* (barragool, gariling or red gubinge) and *T. petiolaris* (marool or blackberry). Woodlands, mangroves and other adjacent ecological communities are likely to play a

significant complementary role in the provision of food and habitat resources for mobile frugivores (Black et al., 2010) and thereby contribute to the maintenance of connectivity.

It is also important to consider the surrounding environment and landscape context outlined on page 14.

Geographic extent and patch distribution

While there has been no detailed modelling of the likely pre-European distribution of the ecological community, it has been estimated that the ecological community formerly occupied up to 2800 ha (Black et al., 2010; DEC, unpublished).

The current extent of the ecological community is estimated to range from 2300 to 2685 ha, based on recent vegetation surveys (Black et al., 2010; DEC, unpublished). The majority of patches (94%) are less than 100 ha in size (Table 3).

Table 3. Patch size distribution for the Monsoon vine thickets on the coastal sand dunes of Dampier Peninsula ecological community in relation to thresholds for fragmentation in Criterion 2 under the EPBC Act.

Thresholds		Size range (ha)	No. patches	% patches	Cumulative %	
Restricted	Very Restricted	< 10	28	36.4	36	94
		> 10-100	44	57.1		
		> 100	5	6.5		
		Total	77	100		

Source: analysis of known patches of the ecological community based on data from Fisher et al. (unpublished).

National context and existing protection

The Monsoon vine thickets on the coastal sand dunes of Dampier Peninsula is listed as a vulnerable ecological community on the state's list of threatened ecological communities endorsed by the Western Australia Minister for the Environment. The state-listed ecological community corresponds with the description and known distribution of the national ecological community, although the state-listed ecological community does not specify condition thresholds. Under the Western Australian *Wildlife Conservation Act 1950*, individual species of plants and animals are also protected.

The Dampier Monsoon Vine Thickets contains habitat for at least four threatened fauna species listed under the EPBC Act (Appendix B, Table B3) and at least five threatened flora species listed under the *Wildlife Conservation Act 1950* (Appendix B, Table B2).

The National Heritage listing of West Kimberley overlaps within the northern end of the Dampier Peninsula; however, the Dampier Monsoon Vine Thicket patches are not part of the Heritage listed area.

Further details on national context including level of protection in reserves can be found at Appendix D.

Summary of threats

The key threats to the ecological community are summarised below:

- Inappropriate fire regimes. Fires are severely impacting the ecological community causing changes in species composition and patches to contract over time.
- Invasive species. Feral animals browse and damage native vegetation plus eat native or displace fauna. Weed species are replacing native species, changing vegetation structure and altering fire regimes causing patches to decline over time.
- Clearance and disturbance. This can further fragment or degrade remaining patches, increasing the risk of patches becoming more isolated and vulnerable to local extinction.
- Altered hydrology. Developments can impact on local microclimates, groundwater access and surface runoff changing hydrological input for vegetation.
- Climate change. Trends suggest that increased frequency and severity of weather events are likely to adversely affect the hydrological and fire regimes operating on the ecological community.

A detailed description of key threats is at Appendix E.

Summary of eligibility for listing against EPBC Act criteria

Criterion 1 – Decline in geographic distribution

The Assessment against criterion 1 for the Dampier Monsoon Vine Thickets is as follows:

- The ecological community occurs as naturally fragmented patches from Broome in the south-west to One Arm Point in the north to Goodenough Bay in the south-east of the Dampier Peninsula.
- The pre-European extent of the ecological community was estimated to be about 2800 ha.
- The current extent of the ecological community is estimated to be between 2300 and 2685 ha.
- The decline in extent of the ecological community is in the order of 4.1 to 18%.

The ecological community has not undergone a significant decline in its geographic distribution. Therefore, the ecological community is **not eligible** for listing in any category under this criterion.

Criterion 2 – Small geographic distribution coupled with demonstrable threat

The Assessment against criterion 2 for the Dampier Monsoon Vine Thickets is as follows:

- The extent of occurrence is estimated to be about 194 700 ha, which is generally indicative of a limited geographic distribution.
- The area of occupancy is presently estimated to be up to 2685 ha, indicative of a restricted geographic distribution.
- The majority (94%) of known patches of the ecological community are less than 100 ha in size and (36%) are less than 10 ha in size. This is also consistent with a restricted geographic distribution.
- The ecological community is subject to ongoing and demonstrable threats as identified above, and detailed in Appendix E. The threats could cause the ecological community to be lost in the medium-term future.

The ecological community has a restricted distribution, on the basis of fragmented patch size and area of occupancy, and that it is subject to a range of ongoing threats that could cause it to be lost in the medium-term future. Therefore, the ecological community has demonstrated to have met the relevant elements of Criterion 2 to make it **eligible** for listing as **vulnerable**.

Criterion 3 – Loss or decline of functionally important species

There is little information about the ecological roles and functional importance of species that are specific to the Dampier Monsoon Vine Thickets. Therefore, the ecological community is **not eligible** for listing in any category under this criterion.

Criterion 4 – Reduction in community integrity

Indicators of reduction in community integrity for the Dampier Monsoon Vine Thickets are as follows:

- The existing patches of Dampier Monsoon Vine Thickets are naturally fragmented. About 94% of the known 77 patches are less than 100 ha in size.
- Many of the plant species in the ecological community are fire sensitive and do not readily recover. Repeated uncontrolled fires are impacting many patches over short intervals with a median number of 4.5 fires per patch over the decade 2000–2010. As many of the patches have a high edge to area ratio due to their generally linear shape, edges are in decline, further reducing core areas. An increase in the frequency and intensity of fires, particularly in the late dry season can lead to a loss of plant diversity, canopy cover and

ground cover. This in turn can lead to increased invasion of the patch core by transformer weeds, such as invasive grasses and vines, which promote further fires.

- A range of weeds has the potential to smother and outcompete native plants in the ecological community. Weeds have been recorded in approximately 60% of surveyed patches. Many of the weeds in the Dampier Monsoon Vine Thickets are well established, highly invasive and can alter fire regimes to the edges and core of the ecological community.
- In addition to the impacts of altered fire regimes and weed invasion, other disturbances are acting on the ecological community. These include feral populations of domestic stock, which can reduce canopy cover, remove native regrowth and directly disrupt the effective regeneration of plant species. Predators, such as cats can impact native fauna by direct predation or competition for resources.

The effects of severe fragmentation, the small size and isolation of most remnants, the combined impacts from inappropriate fire regimes, invasive weeds and pest animals have severely reduced the community's integrity, disrupted ecological processes and consequently impaired its ability to respond to natural and anthropogenic pressures.

The reduction in integrity experienced by the ecological community is **severe** and regeneration is unlikely in the near future. Therefore, the ecological community is **eligible** for listing as **endangered** under this criterion.

Criterion 5 – Rate of continuing detrimental change

There are no quantitative data about the rate of continuing detrimental change for the Dampier Monsoon Vine Thickets over the immediate past or projected for the immediate future. Therefore, the ecological community is **not eligible** for listing in any category under this criterion.

Criterion 6 – Quantitative analysis showing probability of extinction

There are no quantitative data available to assess this ecological community under this criterion. Therefore, it is **not eligible** for listing under this criterion.

Further details about how the ecological community was judged against the EPBC Act listing criteria can be found at Appendix F.

PRIORITY RESEARCH AND CONSERVATION ACTIONS

Research priorities

Research priorities that would inform future regional and local priority actions for the Dampier Monsoon Vine Thickets include:

- Research the most effective control methods for the most damaging weed species that infest the ecological community e.g. neem (*Azadirachta indica*), buffel grass (*Cenchrus ciliaris*), horehound (*Hyptis suaveolens*), coffee bush (*Leucaena leucocephala*), hairy morning glory (*Merremia dissecta*) and wild passionfruit (*Passiflora foetida*).
- Investigate the importance of landscape scale gene flow and its implications for management of remnants, associated fauna, plant and animal interactions and longer term ecological function. This includes research into optimal distances between remnants and remnant sizes that are crucial for a range of flora and fauna movements.
- Design and implement a monitoring program or support and enhance existing programs for the ecological community and associated threatened species.
- Undertake or support and enhance existing survey programs to locate and map remnants and other occurrences of the ecological community, as well as identify key fauna species and threatened species that occur in the ecological community.
- Undertake or support research, monitoring and evaluation to determine the relative biodiversity, conservation benefits of remnants, areas of regeneration and supplementary planting.
- Assess the vulnerability of the ecological community to climate change.
- Undertake or support analysis of the hydrological needs of the ecological community including groundwater and occult precipitation.

Priority recovery and threat abatement actions

The following priority recovery and threat abatement actions should be implemented to support the recovery of the Dampier Monsoon Vine Thickets:

Habitat Loss, Disturbance and Modification

- Protect and conserve remaining areas of the ecological community. Further clearance of this endangered ecological community should be avoided.
- Maintain and reconnect wildlife corridors or linkages and ensure that areas of particularly high quality, connectivity or importance in a landscape context, are protected.
- Monitor the progress of recovery, through improved mapping, estimates of extent and condition assessments of the ecological community.
- Develop and implement appropriate, consistent and best practice adaptive management actions to maintain the biodiversity, including the threatened species, of the ecological community.
- Avoid changes to hydrology that may result in changes to the natural hydrological regime, including drainage and increase or decrease in run-off, salinity or pollution. In particular, manage any potential adverse effects on groundwater.
- Liaise with local councils and state authorities to ensure new developments, road works, maintenance activities, or other activities involving substrate or vegetation disturbance in areas where the ecological community occurs, do not adversely impact the ecological community.

- Liaise with planning authorities to ensure that planning takes the protection of the ecological community into account, with due regard to principles for long-term conservation.
- Apply buffer zones between the ecological community and development zones.

Impacts from urban and other developments

- Where appropriate, fence significant remnants in or adjacent to urban or tourist areas and limit access for vehicles, in consultation with Traditional Owners, local and state authorities.
- Support local patch management through Indigenous ranger groups, local conservation groups and regional bodies (e.g. Australian Wildlife Conservancy, Society for Kimberley Indigenous Plants and Animals, West Kimberley Nature Project, Rangelands Natural Resource Management Authority).

Invasive Species

- Target control of key weeds that threaten the ecological community using appropriate methods. Manage sites to prevent the introduction of new, or further spread of, invasive weeds.
- Discourage the planting of invasive species in developments adjacent or near to the ecological community.
- Encourage appropriate use of local native species in developments in the region through local government and industry initiatives and best practice strategies.
- Ensure chemicals, or other mechanisms used to manage weeds, do not have significant adverse, non-target impacts on the ecological community.
- Control invasive pest animals to allow natural regeneration, especially for threatened species, at known sites through coordinated landscape-scale control programs.

Trampling, Browsing or Grazing

- Exclude species such as cats, cattle, donkeys and pigs from patches of the ecological community.

Fire

- Exclude fire where appropriate. Ensure that managed fires and, where possible, wildfires do not enter buffer zones around remnants.
- Discourage the use of fire as a means to control high biomass and ecosystem transforming weeds in or near to Dampier Monsoon Vine Thicket remnants.
- Manage fires in adjacent vegetation e.g. ensure appropriate fuel load and buffer management in adjacent pindan ecological communities is undertaken, avoiding mid-late dry season, to minimise the risk of fire in the ecological community.
- Negotiate appropriate standing procedures with local fire authorities, in relation to establishing fire control lines to avoid destruction of the ecological community.

Conservation Information

- Maintain liaison with managers of land on which the ecological community occurs.
- Involve Traditional Owners/land managers/Indigenous ranger groups in, and promote community programs that assist with the conservation of the ecological community.

- In consultation with Traditional Owners, develop sustainable management guidelines and technical material to assist land managers, including measures to address inappropriate fire regimes, invasive animal management, weed management and canopy health and maintenance.
- In consultation with Traditional Owners, develop or support appropriate existing education programs, information products and signage to help the public recognise the presence and importance of the ecological community, and their responsibilities under state and local regulations and the EPBC Act.
- Raise awareness of the ecological community within State Government and regional authorities (including the Rangelands Natural Resources Management Authority), local authorities and the local community (e.g. through active conservation and Indigenous ranger groups).
- Raise awareness about the importance of large native fruiting trees, and shrubs and vines, as well as dead trees, as faunal habitat.
- Investigate opportunities for inclusion of the ecological community in any proposed reserve tenure, including Indigenous Protected Areas.

Enable Recovery of Additional Sites

- Consider priority conservation funding for patches of Dampier Monsoon Vine Thickets in consultation with local and state authorities, non-government organisations and Indigenous Ranger groups.
- Plant local indigenous vine thicket species to facilitate landscape processes and regeneration.
- Investigate options to maintain and improve connectivity, including the protection of adjoining vegetation and the replanting of key local canopy species.
- Develop seed harvesting and propagation techniques (having acquired the necessary permits and land access permission required) for Dampier Monsoon Vine Thickets species not already available from nurseries to facilitate the species diversity in revegetation sites.
- Ensure that any revegetation is undertaken in an appropriate manner.

Existing management actions/plans

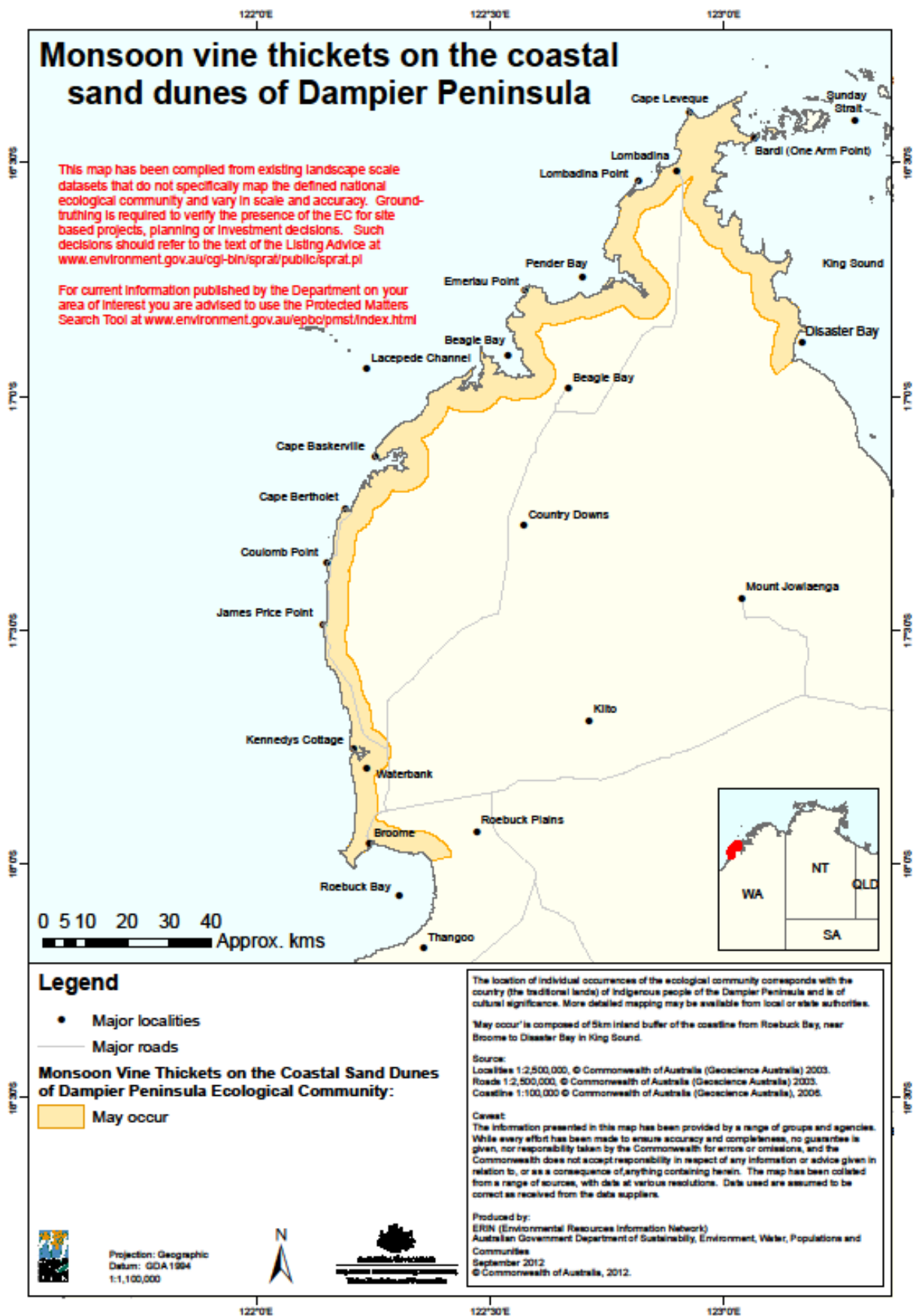
There is no approved state recovery plan for the ecological community. However, there are various local conservation groups and Indigenous ranger groups undertaking monitoring, weed control, localised fire management and restoration programs, primarily in monsoon vine thickets of the Dampierland bioregion. Some management actions are also being conducted in collaboration with the Western Australian Department of Environment and Conservation and the Shire of Broome.

Recovery plan recommendation

A recovery plan for this ecological community will be developed because consistent planning, implementation and coordination of recovery actions is required for the entire range of the ecological community which would involve state, regional and numerous local land managers.

APPENDICES

Appendix A – Distribution map



Appendix B – Species lists

Table B1. Characteristic plant species of the Monsoon vine thickets on the coastal sand dunes of Dampier Peninsula ecological community

This is an indicative rather than comprehensive list of plant species present in the ecological community. Patches may not include all species on the lists or may include other species not listed. Scientific names are current as at August 2012.

Sources: Kenneally et al., 1991; McKenzie et al., 1991; Kenneally et al., 1996; Lands, 1997; Black et al., 2010; DEC, unpublished.

Scientific name	Common name
Trees	
<i>Acacia tumida</i>	wongai
<i>Atalaya hemiglauca</i>	western whitewood
<i>Atalaya variifolia</i>	wingleaf whitewood
<i>Bauhinia cunninghamii</i>	Bauhinia, jigal, joom
<i>Brachychiton diversifolius</i> subsp. <i>diversifolius</i>	darlab, gorr, gorr, kawoorrkaworr, northern kurrajong,
<i>Canarium australianum</i>	styptic tree
<i>Celtis philippensis</i>	goonlji
<i>Corymbia bella</i>	weeping ghost gum
<i>Corymbia flavescens</i>	apple, bastard or cabbage ghost gum
<i>Corymbia greeniana</i>	Dampier's bloodwood
<i>Corymbia opaca</i>	
<i>Corymbia polycarpa</i>	long fruited bloodwood
<i>Cupaniopsis anacardioides</i>	tuckeroo
<i>Diospyros humilis</i>	ebony wood, birimbir
<i>Diospyros maritima</i>	
<i>Ehretia saligna</i>	native willow, peachwood
<i>Erythrophleum chlorostachys</i>	ironwood
<i>Eucalyptus camaldulensis</i> subsp. <i>obtusata</i>	river red gum
<i>Eucalyptus miniata</i>	woollybutt, manowan
<i>Eucalyptus tectifica</i>	Darwin box, grey box,
<i>Exocarpos latifolius</i>	mistletoe tree
<i>Ficus aculeata</i>	sandpaper fig
<i>Ficus platypoda</i>	
<i>Ficus virens</i>	banyan or strangler fig, albay
<i>Grevillea pyramidalis</i>	caustic tree, maangga
<i>Grewia breviflora</i>	currant or coffee fruit, goolmi, gullego
<i>Gyrocarpus americanus</i> subsp. <i>pachyphyllus</i>	coolaman tree, helicopter tree, stinkwood
<i>Hakea arborescens</i>	tree hakea, yellow hakea
<i>Hakea macrocarpa</i>	
<i>Lophostemon grandiflorus</i> subsp. <i>grandiflorus</i>	lardik

Scientific name	Common name
<i>Mallotus nesophilus</i>	badarrbadarr, yellow ball flower
<i>Melaleuca alsophila</i>	saltwater paperbark
<i>Melaleuca dealbata</i>	garnboorr
<i>Mimusops elengi</i>	joongoon, mamajen,
<i>Panadanus spiralis</i>	common screwpine, idool, jarmirdany, manbang
<i>Parinari nonda</i>	nonda
<i>Persoonia falcata</i>	gamaloon, geebung, ngarliwarny, wankirr, wild pear
<i>Pittosporum moluccanum</i>	
<i>Planchonia careya</i>	cocky apple, goolay
<i>Premna acuminata</i>	firestick tree
<i>Santalum lanceolatum</i>	tropical sandalwood
<i>Sersalisia sericea</i>	Mangarr, minyyuru
<i>Syzygium eucalyptoides</i> subsp. <i>bleeseri</i>	wild apple, iilarr
<i>Terminalia canescens</i>	wingnut tree
<i>Terminalia ferdinandiana</i>	gabiny, gubinge, kabiny, madoor
<i>Terminalia ferdinandiana</i> x <i>Terminalia petiolaris</i> (hybrid)	red gubinge
<i>Terminalia petiolaris</i>	blackberry tree, marool, narwulu
<i>Thespesia populneoides</i>	
<i>Ventilago viminalis</i>	medicine bark, supplejack
Shrubs	
<i>Abutilon indicum</i>	Indian lantern flower
<i>Acacia bivenosa</i>	Cable Beach wattle, dune wattle
<i>Acacia coleii</i>	candelabra wattle, Cole's wattle, lirriringkirn, limarrkoodkood, noomoorrgoodoord, soap wattle
<i>Acacia eriopoda</i>	Broome pindan wattle
<i>Acacia monticola</i>	red wattle
<i>Acacia monticola</i> aff.	
<i>Acacia platycarpa</i>	ghost wattle
<i>Acacia wickhamii</i>	
<i>Adriana tomentosa</i> var. <i>hookeri</i>	
<i>Androcaloxophylla</i>	
<i>Breynia cernua</i>	
<i>Bridelia tomentosa</i>	amam
<i>Calytrix exstipulata</i>	Kimberley heath, turkey bush
<i>Carissa spinarum</i>	conkerberry
<i>Caesalpinia major</i> (also considered a climber)	Goolyi
<i>Clerodendrum floribundum</i> var. <i>ovatum</i>	
<i>Clerodendrum tomentosum</i> var. <i>mollissima</i>	

Scientific name	Common name
<i>Codonocarpus cotinifolius</i>	desert poplar
<i>Crotalaria cunninghamii</i>	green birdflower, minmin, oorlgoo, parrot pea
<i>Croton habrophyllus</i>	
<i>Cullen martinii</i>	
<i>Cyperus bulbosus</i>	bush onion, niarlboon, niyalboon, yarrinyarri
<i>Diospyros rugosula</i>	
<i>Dodonaea hispidula</i>	
<i>Dodonaea platyptera</i>	broad-winged hop bush
<i>Flueggea virosa</i> subsp. <i>melanthesoides</i>	goorralgar, goowal, snowball bush
<i>Glycosmis</i> sp.	
<i>Gossypium australe</i>	
<i>Grevillea refracta</i>	silverleaf grevillea
<i>Grewia retusifolia</i>	dog's balls, dysentery bush, turkey bush
<i>Gyrostemon tepperi</i>	
<i>Helicteres rhynchoarpa</i>	
<i>Hibiscus apodus</i>	yellow hibiscus
<i>Hibiscus</i> sp.	
<i>Hypoestes floribunda</i> var. <i>varia</i>	musk-scented plant
<i>Keraudrenia exastia</i>	fringed keraudrenia
<i>Luvunga monophylla</i>	
<i>Myoporum montanum</i>	boobialla, gawar, native myrtle
<i>Pavetta kimberleyana</i>	
<i>Phyllanthus reticulatus</i>	
<i>Plumbago zeylanica</i>	
<i>Psydrax pendulina</i>	
<i>Senna costata</i>	ram's horns
<i>Sida hackettiana</i>	golden rod
<i>Sida rohlenae</i> subsp. <i>occidentalis</i>	
<i>Solanum cunninghamii</i>	bunug, langgoorr, nankoorr
<i>Tephrosia rosea</i>	Flinders River poison
<i>Triumfetta</i> sp.	
<i>Trophis scandens</i>	
Climbers / Vines	
<i>Abrus precatorius</i>	Crab's eye bean
<i>Adenia heterophylla</i> subsp. <i>australis</i>	
<i>Asparagus racemosus</i>	asparagus fern
<i>Canavalia rosea</i>	Jack bean, beach bean
<i>Capparis jacobsii</i> aff.	
<i>Capparis lasiantha</i>	bush caper

Scientific name	Common name
<i>Capparis sepiaria</i>	
<i>Cassytha filiformis</i>	jirrawany, koodikoodi, wagalwagal
<i>Cucumis maderaspatanus</i>	
<i>Cynanchum carnosum</i>	
<i>Flagellaria indica</i>	lawyer vine, supplejack
<i>Gymnanthera oblonga</i>	harpoon bud
<i>Ipomoea pes-caprae</i> subsp. <i>brasiliensis</i>	beach morning glory
<i>Jacquemontia paniculata</i>	
<i>Jasminum didymum</i>	
<i>Operculina aequisejala</i>	
<i>Opilia amentacea</i>	
<i>Parsonsia kimberleyensis</i>	
<i>Sarcostemma</i> sp.	
<i>Sarcostemma viminalis</i>	caustic vine, milkbush
<i>Secamone timoriensis</i>	
<i>Tinospora smilacina</i>	snake vine
<i>Tylophora cinerascens</i>	oyster-catcher bill
<i>Tylophora flexuosa</i>	
<i>Vigna vexillata</i> var. <i>angustifolia</i>	wild cowpea
Hemiparasites (mistletoes)	
<i>Amyema benthamii</i>	
<i>Amyema bifurcata</i>	
<i>Amyema sanguinea</i> var. <i>sanguinea</i>	Christmas mistletoe
<i>Cassytha capillaris</i> (also considered a climber)	
<i>Cassytha filiformis</i> (also considered a climber)	
<i>Dendrophthoe acacioides</i> subsp. <i>acacioides</i>	
<i>Lysiana spathulata</i> subsp. <i>spathulata</i>	
<i>Santalum lanceolatum</i> (also considered a tree)	
Epiphytes	
<i>Cymbidium canaliculatum</i>	tree orchid
Herbs	
<i>Abutilon</i> sp.	
<i>Achyranthes aspera</i>	chaff flower
<i>Amaranthus</i> sp.	
<i>Amaranthus undulatus</i> (formerly <i>A. pallidiflorus</i>)	
<i>Boerhavia dominii</i>	tarvine
<i>Boerhavia</i> sp.	

Scientific name	Common name
<i>Cleome viscosa</i>	mustard bush, spider flower, tick weed, wild caia
<i>Crotalaria crispata</i>	walkabout
<i>Crotalaria medicaginea</i>	rattlepods
<i>Cucumis maderaspatanus</i> (formerly <i>Mukia maderaspatana</i>)	Madras sea pumpkin, bristly Bryony
<i>Euphorbia alsiniflora</i>	
<i>Gomphrena pusilla</i>	
<i>Heliotropium</i> sp.	
<i>Indigofera linifolia</i>	
<i>Portulaca oleracea</i>	common purslane, purslane
<i>Polycarpha</i> sp.	
<i>Polymeria distigma</i>	
<i>Ptilotus lanatus</i> var. <i>lanatus</i>	
<i>Ptilotus nobilis</i> subsp. <i>nobilis</i>	pink mulla mulla
<i>Ptilotus polystachyus</i>	green mulla mulla, seedyhead
<i>Sida</i> sp.	
<i>Spermacoce auriculata</i>	
<i>Tacca leontopetaloides</i>	
<i>Tephrosia rosea</i>	Flinders River poison
<i>Trianthema portulacastrum</i>	giant pigweed
<i>Trichodesma zeylanicum</i>	camel bush
Graminoids (grasses and grasslike plants)	
<i>Bulbostylis barbata</i>	watergrass
<i>Cenchrus biflorus</i> (N.B. This species is a bulbous perennial with annual leaves)	Gallon's curse
<i>Cenchrus elymoides</i>	
<i>Chrysopogon pallidus</i>	ribbon grass
<i>Cymbopogon</i> sp.	
<i>Cyperus bulbosus</i>	
<i>Cyperus nervulosus</i>	
<i>Enneapogon pallidus</i>	conetop nineawn
<i>Eragrostis cumingii</i>	Cumings love grass
<i>Eriachne semiciliata</i>	
<i>Fimbristylis</i> sp.	
<i>Heteropogon contortus</i>	black or bunch speargrass
<i>Perotis rara</i>	comet grass
<i>Setaria apiculata</i>	pigeon grass
<i>Spinifex longifolius</i>	beach spinifex
<i>Triodia bitextura</i>	
<i>Triodia microstachya</i>	

Scientific name	Common name
<i>Triodia</i> sp.	
<i>Whiteochloa airoides</i>	creeping panic

Table B2. Rare plant species which occur in or adjacent to the Monsoon vine thickets on the coastal sand dunes of Dampier Peninsula ecological community

Scientific names are current as at August 2012.

Source: Black et al., 2010; Smith, 2012.

Scientific Name	Growth Form	Conservation Status	
		WA	EPBC
<i>Eriachne</i> sp. Dampier Peninsula (K.F Kenneally 5946)	grass	Priority 3	Not listed
<i>Gomphrena pusilla</i>	herb	Priority 2	Not listed
<i>Parsonsia kimberleyensis</i>	climber	Priority 1	Not listed
<i>Pittosporum moluccanum</i>	tree	Priority 4	Not listed
<i>Polymeria distigma</i>	herb	Priority 3	Not listed

Table B3. Fauna that may occur in the Monsoon vine thickets on the coastal sand dunes of Dampier Peninsula ecological community

Scientific names are current as at August 2012.

* Species thought to be no longer present in this region.

Sources: Johnstone and Burbidge, 1991; McKenzie et al., 1991; Churchill, 2008; Black et al., 2010; Biota, 2010; Wilson and Swan, 2010; Smith, 2012.

Scientific name	Common name	Conservation status	
		WA	EPBC
Mammals			
<i>Canis lupus</i>	dingo		
<i>Chalinolobus gouldii</i>	Gould's wattled bat		
<i>Chalinolobus nigrogriseus</i>	hoary wattled bat		
<i>Chaerephon jobensis</i>	northern freetail bat		
<i>Isoodon auratus</i> *	golden bandicoot	Schedule 1	Vulnerable
<i>Macroglossus minimus</i>	northern blossom bat		
<i>Macropus agilis</i>	agile wallaby		
<i>Macrotis lagotis</i>	greater bilby	Schedule 1	Vulnerable
<i>Mesembriomys macrurus</i> *	golden-backed tree-rat	Priority 4	Vulnerable
<i>Miniopterus schreibersii oriana</i>	northern bentwing bat		
<i>Mormopterus beccarii</i>	Beccari's freetail bat		
<i>Mormopterus loriae cobourgiana</i>	mangrove freetail bat		
<i>Nyctophilus arnhemensis</i>	Arnhem long-eared bat		
<i>Nyctophilus daedalus</i>	northern long-eared bat		
<i>Nyctophilus geoffroyi</i>	lesser long-eared bat		
<i>Scotorepens greyii</i>	little broad-nosed bat		
<i>Scotorepens sanborni</i>	northern broad-nosed bat		
<i>Tachyglossus aculeatus</i>	echidna		
<i>Taphozous georgianus</i>	common sheaftail bat (cave bat)		
<i>Trichosurus vulpecula arnhemensis</i>	northern brushtail possum		
<i>Pipistrellus westralis</i>	mangrove pipistrelle		
<i>Pteropus alecto</i>	black flying fox		
<i>Pteropus scapulatus</i>	little red flying fox		
Birds			
<i>Aprosmictus erythropterus</i>	red-winged parrot		
<i>Artamus leucorhynchus</i>	white-breasted woodswallow		
<i>Artamus minor</i>	little woodswallow		
<i>Artamus personatus</i>	masked wood-swallow		
<i>Cacatua sanguinea</i>	little corella		

Scientific name	Common name	Conservation status	
		WA	EPBC
<i>Cacomantis variolosus</i>	brush cuckoo		
<i>Calyptorhynchus banksii</i>	red-tailed black cockatoo		
<i>Colluricincla harmonica</i>	grey shrike-thrush		
<i>Conopophila rufogularis</i>	rufous-throated honeyeater		
<i>Coracina novaehollandiae</i>	black-faced cuckoo-shrike		
<i>Coracina papuensis</i>	white-bellied cuckoo-shrike		
<i>Dicaeum hirundinaceum</i>	mistletoebird		
<i>Eolophus roseicapillus</i>	galah		
<i>Erythrura gouldiae</i>	Gouldian finch	Schedule 1	Endangered
<i>Falco peregrinus</i>	peregrine falcon	Schedule 4	
<i>Geopelia humeralis</i>	bar-shouldered dove		
<i>Geopelia striata placida</i>	peaceful dove		
<i>Gerygone olivacea</i>	white-throated gerygone, white-throated flyeater		
<i>Lichenostomus flavescens</i>	yellow-tinted honeyeater		
<i>Lichenostomus unicolor</i>	white-gaped honeyeater		
<i>Lichenostomus virescens</i>	singing honeyeater		
<i>Lichmera indistincta</i>	brown honeyeater		
<i>Malurus lamberti</i>	variegated fairy-wren		
<i>Melithreptus gularis</i>	black-chinned honeyeater		
<i>Myiagra ruficollis mimikae</i>	broad-billed flycatcher		
<i>Myzomela erythrocephala</i>	red-headed honeyeater		
<i>Pachycephala melanura melanura</i>	mangrove golden whistler		
<i>Pachycephala rufiventris</i>	rufous whistler		
<i>Philemon citreogularis</i>	little friarbird		
<i>Podargus strigoides</i>	tawny frogmouth		
<i>Pomatostomus temporalis</i>	grey-crowned babbler		
<i>Ptilinopus regina ewingii</i>	red-crowned fruit-dove		
<i>Ptilonorhynchus nuchalis</i>	great bowerbird		
<i>Rhipidura rufiventris</i>	northern fantail		
<i>Taeniopygia bichenovii</i>	double-barred finch		
<i>Todiramphus sanctus</i>	sacred kingfisher		
<i>Zosterops luteus</i>	yellow white-eye		
Reptiles			
<i>Carlia rufilatus</i>			
<i>Carlia triacantha</i>			
<i>Ctenotus inornatus</i>			
<i>Cryptoblepharus</i>	metallic snake-eyed skink		

Scientific name	Common name	Conservation status	
		WA	EPBC
<i>metallicus</i>			
<i>Cryptoblepharus pulcher</i>	elegant snake-eyed skink		
<i>Cryptoblepharus ruber</i>	tawny snake-eyed skink		
<i>Cryptoblepharus tyttos</i>	pygmy snake-eyed skink		
<i>Delma tinctoria</i>			
<i>Diplodactylus conspicillatus</i>	fat tailed gecko		
<i>Eremiascincus isolepis</i>			
<i>Gehyra pilbara</i>			
<i>Glaphyromorphus isolepis</i>			
<i>Heteronotia binoei</i>	Bynoe's gecko		
<i>Lerista apoda</i>			
<i>Lerista bipes</i>			
<i>Lerista greeri</i>			
<i>Lerista separanda</i>		Priority 2	
<i>Lialis burtonis</i>	Burton's snake-lizard		
<i>Notoscincus ornatus</i>			
<i>Pseudechis australis</i>	King brown snake, mulga snake		
<i>Ramphotyphlops diversus</i>			
<i>Simoselaps minimus</i>	Dampierland burrowing snake, jooroo	Priority 2	
<i>Strophurus ciliaris</i>			
<i>Tiliqua multifasciata</i>	Centralian blue-tongue		
<i>Tiliqua scincoides intermedia</i>	northern blue tongue		
<i>Ramphotyphlops diversus</i>			
<i>Varanus goudii</i>	Gould's goanna		
<i>Varanus tristis</i>	freckled monitor		
Invertebrates			
<i>Eremopeas interioris</i>	outback awl snail		
<i>Gastrocopta mussoni</i>	desert land snail		
<i>Gastrocopta pediculus</i> (syn. <i>G. simplex</i>)	weakly toothed pupasnailed		
<i>Nesopupa scotti</i> (syn. <i>Pupa mooreana</i>)	blunt golden pupasnailed		
<i>Pupisoma orcula</i>	Oriental toothless pupasnailed		
<i>Quistrachia leptogramma</i>	land snail		

Scientific name	Common name	Conservation status	
		WA	EPBC
Amphibians			
<i>Litoria caerulea</i>	green tree frog		
<i>Platyplectrum ornatus</i>	ornate burrowing frog		

Table B4. Weed species that may occur in the Monsoon vine thickets on the coastal sand dunes of Dampier Peninsula

Scientific names are current as at August 2012.

Source: Black et al., 2010.

Scientific Name	Common Name	Growth form
<i>Aerva javanica</i>	kapok bush	perennial herb
<i>Azadirachta indica</i>	neem tree	tree
<i>Cenchrus biflorus</i>	Gallon's curse	annual grass
<i>Cenchrus ciliaris</i>	buffel grass	perennial tussock grass
<i>Cenchrus setiger</i>	birdwood grass	perennial tussock grass
<i>Clitoria ternatea</i>	butterfly pea, Darwin pea	herbaceous perennial vine
<i>Citrullus lanatus</i>	pie melon	annual herb or climber
<i>Cryptostegia madagascariensis</i>	rubber vine*	vine, climber
<i>Hyptis suaveolens</i>	hyptis, horehound, mint weed	annual or perennial, herb
<i>Ipomoea quamoclit</i>	morning glory	climbing annual, herb
<i>Jatropha gossypifolia</i>	bellyache bush*	shrub
<i>Lantana camara</i>	lantana*	shrub or climber
<i>Leucaena leucocephala</i>	coffee bush	shrub
<i>Macroptilium atropurpureum</i>	siratro, black pea	perennial herb or climber
<i>Merremia aegyptia</i>	hairy merremia	perennial herb or climber
<i>Merremia dissecta</i>	hairy morning glory, white convolvulus creeper	vine, climber
<i>Passiflora foetida</i> var. <i>hispida</i>	wild passionfruit	woody climber
<i>Peltophorum pterocarpum</i>	yellow poinciana tree	deciduous tree
<i>Stachytarpheta cayennensis</i>	snakeweed	woody perennial herb or shrub
<i>Tribulus terrestris</i>	caltrop	prostrate annual herb
<i>Vinca major</i>	blue periwinkle, vinca	scrambling perennial herb

* Weed of National Significance

Appendix C – Detailed description of biology and ecological processes

Vegetation dynamics

There are a small number of closed canopy vegetation formations in the wet tropics of Western Australia, including: rainforests, *Melaleuca-Pandanus* stands fringing watercourses and mangroves (McKenzie, 1991). Rainforests and vine thickets in Western Australia are among the smallest and most open deciduous forests of northern Australia (McKenzie et al., 1991). They are typically patchy (Kahn and Lawrie, 1987) due to local topography, hydrology, geology, incidence of disturbance and historical distribution of rainforests within an area.

Monsoon vine thickets mainly occur as small, scattered patches along the Kimberley coastline and for a short distance inland (McKenzie et al., 1987), with very few exceeding 100 ha. Patches are usually linear and narrow, running parallel to the coastal dunes and associated swales. Surveys conducted by McKenzie et al. (1991) and Black et al. (2010) found that Dampier Monsoon Vine Thicket patch size varied greatly but the mean was 32 ha. The scattered distribution and variable size of monsoon vine thickets means the loss or degradation of a single patch can reduce species migration, leaving patches isolated and vulnerable to local extinction.

The Dampier Monsoon Vine Thickets contains many fruits, medicines and tools that are important in Indigenous culture. Many patches are also important sites for Biidin or jila (fresh water under the ground, living water) camping and ceremonial areas and law grounds (Bardi Jawi Oorany Rangers, 2012). Freshwater indicator trees associated with vine thickets include *Lophostemon grandiflorus* and *Pandanus spiralis* (Louise Beames pers. com., 2012). Important bushtucker plants in the ecological community include *Diospyros humilis* (birimbiri), *Flueggea virosa* (goorralgar, goowal), *Grewia breviflora* (goolmi, gullego), *Mimusops elengi* (joongoon, mamajen), *Planchonia careya* (goolay), *Sersalisia sericea* (mangarr, minyyuru), *Syzygium eucalyptoides* (iilarr) and *Terminalia petiolaris* (marool, narwulu) (Noury et al., 2005; Bardi Jawi Oorany Rangers, 2012).

The interactions between fauna, fire and hydrology in vegetation dynamics are discussed below.

Faunal roles and interactions

The closed canopy of the Dampier Monsoon Vine Thickets provides a shady and humid refuge for animals particularly during the dry season when fires in the landscape are more frequent (Johnstone and Burbidge, 1991; Kendrick and Rolf, 1991; Price, 2004). The abundance of fruiting plants within the ecological community also provides relatively rich food resources for many taxa.

The ecological community provides habitat for a number of mammal and bird species which act as pollinators and seed dispersers (Crome and Irvine, 1986; Price et al., 1999; Price, 2004; Neilan et al., 2006; Black et al., 2010). These animals feed on the spatially variable and seasonally complementary fruit and nectar that exist in the ecological community (Johnstone, 1983; Environs Kimberley, 2009; Black et al., 2010). This is similar to the ecology of vine thickets in the Northern Territory, where birds have been shown to track fruit resources with variations in fruit availability (Bach and Price, 1999).

Fauna such as the agile wallaby, rose-crowned fruit-dove, great bowerbird and flying foxes often travel between vine thickets as resources become available. These frugivores help connect patches of the ecological community through dispersing seeds between patches. For example, *Ficus virens* trees provide fruit at varying times of the year across the Dampier Peninsula, and its seeds are dispersed by birds, where they drop the seeds when perching on tree branches (Bardi Jawi Oorany Rangers, 2012). Black flying foxes prefer blossom, pollen (a major source of protein) and fleshy fruit depending on the season although they will also eat

tree leaves. The little red flying fox feeds predominantly on tree and shrub blossom, while the northern blossom bat mainly relies on nectar and pollen. Bats foraging on blossom and pollen become covered in pollen during feeding (Chrome and Irvine, 1986; Palmer et al., 2000; Churchill, 2008).

Fauna such as *Aprosmictus erythropterus* (red-winged parrot), *Ptilonorhynchus nuchalis* (great bowerbird), *Philemon citreogularis* (little friarbird), *Zosterops luteus* (yellow white-eye), rose-crowned fruit-dove and native bees use food and habitat resources from plants in the ecological community such as *Diospyros humilis* (ebony wood, birimbiri), *Grewia breviflora* (goolmi), *Planchonia careya* (goolay), and *Terminalia petiolaris* (marool, nawulu) (Bardi Jawi Oorany Rangers, 2012). In Western Australia, the rose-crowned fruit-dove is at its southern most limit on the Dampier Peninsula and is mainly restricted to the ecological community in this location. Male great bowerbirds use seeds from *Caesalpinia major* (goolyi) to decorate their nest, whilst small birds shelter in this shrub/vine as it is thick and prickly (Kenneally et al., 1996; Bardi Jawi Oorany Rangers, 2012). Birds also nest in plants of the ecological community (Bardi Jawi Oorany Rangers, 2012).

Monsoon rainforests, such as the ecological community, are also used opportunistically by savanna adapted mammals in order to avoid climatic extremes, predators and savanna fires (Bowman and Woinarski, 1996). *Macropus agilis* (agile wallaby) finds refuge from the heat of the day in the dense vegetation of the ecological community emerging to graze on a variety of plants such as grasses and fallen fruit.

Hydrology

Although the hydrological requirements of the ecological community have not been extensively studied, the position of the ecological community in the landscape suggests that it relies on various hydrological inputs. Indigenous people of the Kimberley often identify vine thickets and rainforest patches as areas near jila (living water/ groundwater). Flora taxa such as albay (fig), manbung (pandanus) and mutgarr (paperbark) are also closely associated with freshwater close to the surface. Many Kimberley vine thicket patches occur adjacent to or on groundwater springs or shallow aquifers such as permanent soakage sites (Kenneally et al., 1991).

The hydrology is partly influenced by the nature of the soils on the Dampier Peninsula. The pindan soils of the Dampier Peninsula form extensive undulating plains with few organised surface drainage channels, such as watercourses. Where a layer of unconsolidated sand overlies the pindan, water penetration is aided. In these locations, rainfall is usually soaked up by the pindan sandplains, recharging aquifers. However, surface water is often present after heavy rains and seasonal runoff can form sheet flow (Kenneally et al., 1996; Black et al., 2010; BOM, 2011). Concentrated water from precipitation, such as rain, congregates into the recharge zones or swales at the base of the coastal dune systems.

During the dry season, a moist, humid microclimate occurs behind the dune system. When cooler air interacts with warm moist coastal air, high humidity and heavy fogs can occur along the Dampier coast, especially at Broome (Kenneally et al., 1996). Fog and mist condensation settles on the dense and shady canopy of the Dampier Monsoon Vine Thickets. This process is known as occult precipitation and may contribute to the annual hydrological inputs for the ecological community. Studies in upland rainforest have shown occult precipitation can contribute to the groundwater store (DERM, 2007; Australian National University, 2009).

Role of fire

Prior to European colonisation, Indigenous people in northern Australia used fire as a primary landscape management tool, systematically burning parts of the landscape as soon as the fuels dried sufficiently to carry a fire (Jones, 1975; Haynes, 1985, 1991; Russell-Smith et al., 1997, 2003; Yibarbuk et al., 2001; Garde et al., 2009). Small fires that created a patchwork or mosaic were used to control the intensity of the fire and contain the area to be burnt (Kenneally et al., 1996; Russell-Smith et al., 2009c) and to prevent widespread, intense fires late in the dry season (Braithwaite and Estbergs, 1985; Haynes, 1985; Bowman and Panton, 1993). Garde et al. (2009) details substantial ethnographic evidence, including contemporary customary practice, indicating this timing.

As rainforest and vine thicket communities were prime food-gathering areas, Indigenous people would try to protect them from fires by burning away from a rainforest patch early in the dry season (Mangglamarra et al., 1991). Fires burning in the wet or early dry seasons would generally not penetrate rainforests and vine thickets as they were too moist to burn at these times. This management regime reduced fuel load and created burn breaks along walking tracks and around important resources. As a consequence, vegetation such as the ecological community could also act as refugia for many fauna species such as reptiles during fires and seasonal food scarcity (Kendrick and Rolf, 1991; Bowman and Woinarski, 1996). Low intensity, mosaic burning during the early dry season in vegetation adjacent to vine thicket patches shows little impact to the patches (Val English pers. comm., 2012)⁶. However, as the dry season progresses, plant fuels dry and the severity of fire increases (Gill et al., 1996; Russell-Smith and Edwards, 2006) combining to increase the vulnerability of vine thickets to fire damage.

Fire has had a strong influence on the localised distribution and boundary characteristics of rainforests across northern Australia (Russell-Smith and Dunlop, 1987; McKenzie and Belbin, 1991). The size and shape of persisting patches often reflects the level of protection from fire offered by surrounding landforms and vegetation (Russell-Smith and Dunlop, 1987). For example, patches of the ecological community surrounded by rock outcrops or coastal formations such as sand spits are less frequently burnt than patches of the ecological community adjacent to more flammable pindan and savanna woodlands (McKenzie, 1991).

Since European settlement, fire regimes have shifted toward extensive, relatively intense fire events in the mid-late dry season. The impacts of altered fire regimes are discussed in Appendix E.

⁶ This supports anecdotal evidence from Indigenous custodians that the vine thickets 'did not want to burn'.

Appendix D – Detailed description of national context and existing protection

Heritage

On 31 August 2011 the West Kimberley was inscribed on the National Heritage List as a Matter of National Environmental Significance protected by the EPBC Act. Natural values included the vine thickets of the northern Kimberley coast and islands and the Kimberley Plateau, and the Devonian reefs of the west Kimberley. These were identified as having outstanding heritage value to the nation for their evolutionary refugial role that has resulted in high invertebrate richness and endemism. Some patches of the ecological community on the northern end of the Dampier Peninsula overlap with the heritage listing, however, the Dampier monsoon vine thicket patches are not part of the Heritage listed area.

Relationships to State-listed ecological communities

The Monsoon vine thickets on coastal sand dunes of the Dampier Peninsula is listed as a vulnerable ecological community on the Western Australian list of threatened ecological communities endorsed by the Western Australia Minister for the Environment. While there is currently no specific legislation that provides for the listing of threatened ecological communities in Western Australia, there is an informal, non-statutory process to list them. In addition, threatened ecological communities are listed as Environmentally Sensitive Areas under regulations made under the *Environmental Protection Act 1986* that control clearance of native vegetation in Western Australia. Several species of plants and animals that occur in the ecological community are also protected under the *Western Australian Wildlife Conservation Act 1950* (see Appendix B).

The state-listed Monsoon (vine) thickets on the coastal sand dunes of Dampier Peninsula falls within the description and known distribution of the national ecological community, although the state-listed ecological community does not specify condition thresholds.

Relationships to other vegetation classifications

The ecological community corresponds, entirely or in part, to the following vegetation classifications:

National Vegetation Information System (NVIS) (V4.1):

- Major Vegetation Group (MVG) 1: Rainforest and vine thickets
- Major Vegetation Subgroup (MVS) 62: Dry rainforest or vine thickets

Webb et al. (1984):

- Dry tropical (monsoon) forests
 - i. semi-deciduous mesophyll and notophyll vine forest
 - ii. deciduous microphyll vine thicket

Kenneally et al. (1991):

- Group 6 western Kimberley Holocene sand dune patches

Differences to similar or intergrading ecological communities and adjacent vegetation communities

In addition to monsoon vine thickets, the coastal areas of the Dampier Peninsula contain a variety of vegetation communities including coastal shrublands, mangroves, paperbark thickets, saline grasslands, samphire flats, seepage areas and wetlands (Chalmers and Woods, 1987; Kenneally et al., 1996). In many areas the ecological community may intergrade with pindan woodland and low coastal shrublands.

Pindan is a type of woodland common across the Dampier Peninsula. It has a tree layer that is predominantly eucalypts and a middle layer of dense *Acacia* spp. and *Hakea* spp. Pindan also

contains grass species in the understorey, such as *Chrysopogon pallidus* (razorgrass), *Heteropogon contortus* (black speargrass), *Sarga stipoidea* (annual sorghum) and *Triodia schinzii* (feathertop spinifex) (Kenneally et al., 1996).

Closed vine forests of paperbark thickets can also occur in the leeward slopes of larger dune systems on the Dampier Peninsula and may occur adjacent to the Dampier Monsoon Vine Thickets (McKenzie and Kenneally, 1983; Kenneally et al., 1996; Black et al., 2010). These paperbark thickets may reach heights of up to 15 m, with upperstorey trees dominated by paperbark species, such as *Melaleuca cajuputi* (cadjeput) and *M. viridiflora* (broad-leaved paperbark). These thickets are associated with ephemeral swamps and groundwater. The closed vine forests are distinguished from the ecological community by the presence of persistently wet or damp ground and a distinct and well-developed tall tree canopy dominated by paperbarks.

Vine thicket patches also occur north of the Dampier Peninsula in the Northern Kimberley Bioregion, however, they are not considered to be part of the ecological community. The ecological community has a lower rainfall, different geomorphology and floristic makeup to the northern Kimberley vine thickets. The overstorey of northern Kimberley vine thickets contain tree species that are typically absent from the ecological community including *Adansonia gregorii*, *Albizia lebeck*, *Bombax ceiba*, *Cryptocarya cunninghamii*, *Elaeodendron melanocarpum*, *Ganophyllum falcatum*, *Vitex acuminata* and *Ziziphus quadrilocularis* (Kenneally et al., 1991). The understorey of these vine thicket patches also contains large shrub species from the genera *Alectryon*, *Denhamia*, *Micromelum*, *Murraya*, *Strychnos*, *Trema* and *Wrightia* that are typically absent from the ecological community.

Monsoon rainforest in northern Australia, of which Dampier Monsoon Vine Thickets are a subset, has a restricted occurrence of less than <1% of the total land area (Price et al., 1995). As noted by Bowman (2000), monsoon rainforests are wide ranging but with a fragmented distribution of usually small patches (Russell-Smith, 1991) which is characteristic of the Dampier Monsoon Vine Thickets. Many northern Australian patches also occur on coastal sand dunes. Comparison of flora species of the Dampier Monsoon Vine Thickets with patches on similar substrates, such as in the Northern Territory, indicate that there are a number of similarities. However, the diversity of species present in the ecological community is more limited than those in other northern Australia patches e.g. Northern Territory. Flora frequency analysis from available data demonstrated that there was an absence of many of the ecological community's key canopy species in northern vine thicket patches on coastal sand dunes, e.g. *Diospyros humilis*, *Grewia breviflora*, *Mallotus nesophilus* and *Terminalia petiolaris*. Also occurring within the Dampier Monsoon Vine Thickets, but absent from northern patches on coastal dunes, are more ecologically versatile species (i.e. which also occur in the drier adjacent pindan and savanna ecosystems), e.g. *Acacia colei*, *A. tumida*, *Bauhinia cunninghamii*, *Tephrosia rosea* and *Terminalia fernandiana*. The analysis indicated that the ecological community has an idiosyncratic species composition and is sufficiently distinct to be considered different to other northern monsoon rainforest types.

Level of protection in reserves

The Dampier Monsoon Vine Thickets occurs on unallocated crown lands (38%), on land managed by Indigenous people (Aboriginal Reserves – 36%), freehold land (11%) and pastoral leases (six per cent). Approximately nine per cent of the Dampier Monsoon Vine Thickets is located within the Yawuru Conservation Park (Minyirr Coastal Park) and other lands vested in the Shire of Broome. Yawuru Conservation Park is jointly vested with the Yawuru Indigenous people with the Western Australian Department of Environment and Conservation conducting day to day management.

Appendix E – Description of threats

Clearing/fragmentation/disturbance

While the ecological community is naturally fragmented due to landscape position, fire regimes, hydrological requirements and availability of suitable habitat, it functions as a network ecosystem. The scattered distribution and variable size of patches means that the degradation of a single patch can reduce species migration, leaving patches isolated and vulnerable to local extinction. Additional pressures including edge effects and altered fire regimes can further reduce opportunities for pollination and dispersal of plant propagules.

Direct impacts on the ecological community have occurred from clearance for development in areas close to the town of Broome as well as around smaller settlements further north. Patches have been cleared for vehicle access and campsites. Some may have also been cleared for pasture (Black et al., 2010). Clearing reduces the extent of the ecological community and exacerbates patch isolation, reducing connectivity between remnants. Connectivity between remnants of the ecological community and other native vegetation is an important determinant of habitat quality at the landscape scale for native flora and fauna and overall condition and persistence of the ecological community.

Incremental and ongoing disturbance⁷ of the Dampier Monsoon Vine Thickets adversely affects the structural integrity of patches of the ecological community. Disturbance can open up the canopy within a patch thereby enabling invasive flora such as exotic grasses to establish. These species can reduce the ecological community's ability to resist fire, impacting on the structural integrity of the patch, which can also enhance edge effects. If unmanaged, tourism and associated recreational uses of the Dampier Monsoon Vine Thickets may increase disturbance events.

While most of the Holocene dunes on the Dampier Peninsula are stable, shifting dunes in a number of locations has impacted Dampier Monsoon Vine Thickets. For example, near Hunter Creek, Karrakatta Bay and Thomas Bay (Djarindjin) (Harding et al., 2009; DEC pers. comm., 2012). Dunes destabilised by removal and damage of vegetation can smother the ecological community as prevailing winds shift the dune system at a greater rate.

Inappropriate fire regimes

The tropical north of Australia has been characterised by Liedloff and Cook (2007) as “perhaps the most extensive and flammable ecosystem in the world” where fire is a natural disturbance process in the tropical savannas. The regular monsoonal climate promotes rapid grass growth, followed by a period of curing in the dry season (Rangelands NRM, 2009).

Key fire regime issues confronting the Dampier Monsoon Vine Thickets relate to the contemporary frequency of very extensive, relatively non-patchy and severe late dry season wildfires (Yates et al., 2008; Edwards and Russell-Smith, 2009; Val English, pers. comm., 2012). The most vulnerable vegetative components of the Dampier Monsoon Vine Thickets to fire impacts are the patch edges. Russell-Smith and Stanton (2002) found that contemporary fire impacts on monsoon rainforests in northern and northwestern Australia indicated significant widespread damage to the margins of typically small monsoon rainforest patches. Recurring hot fires in adjacent vegetation to the Dampier Monsoon Vine Thickets may cause the patches to contract over time (Black et al., 2010) due to damage to the margins of patches.

Fire damage has been recorded in 32% (20 out of 62) of Dampier Monsoon Vine Thicket patches surveyed on the Dampier Peninsula. Nine of the patches suffered from severe fire damage extending well into the stand and included burnout trees causing/inducing retreat or contraction of the patches (Black et al., 2010). Further, late dry-season fires tend to homogenise

⁷ Disturbance includes collection of timber, removal of branches, the creation of new campsites (permanent and temporary) and development of non-traditional tracks for stock, vehicles and walking.

the vegetation structure, with mid-storey vegetation particularly at risk (Bastin and ACRIS MC, 2008). Significant fire events may have long-term impacts on the ecological community. Comparative aerial photographs (commencing from 1942) of fire-affected patches at Cape Borda in Western Australia appear to show little recovery to the larger trees and shrubs over several decades (Black et al., 2010).

Vegetation disturbances such as damage to canopy species, and ground cover and litter removal due to cattle, vehicles and the formation of tracks and campsites can exacerbate fire impacts. By opening up the canopy of the ecological community, annual and exotic grasses, such as *Cenchrus ciliaris* (buffel grass), can invade a patch leading to an increased fuel load which in turn increases fire intensity (Black et al., 2010). The distribution of exotic species in a patch also effects fire behaviour. Clumps of buffel grass near trees and shrubs can increase localised fire intensity and flame height, damaging woody species (CRC, 2008) (also see Appendix F – Criterion 4).

Fire management

Fire management by Western Australian Government agencies on the Dampier Peninsula has typically involved controlled burning early in the dry season via aerial incendiaries (Black et al., 2010) so that fires are of a lower intensity (Val English, pers. comm., 2012). Despite ongoing fire management for northern Australia, there is growing recognition of the impact of contemporary fire regimes on fire-sensitive components of northern Australian flora and fauna. Monitoring suggests that fire-sensitive vegetation, such as the ecological community remain vulnerable to inappropriate contemporary fire regimes (Woinarski et al., 2005; 2010; Yates et al., 2008).

Significant efforts to address fire management challenges across northern Australia are being undertaken and include the Dampier Peninsula Fire Project (DPFP), EcoFire and the West Kimberley Nature Project. DPFP facilitates planning and implementation of a coordinated early dry season prescribed burning program in conjunction with strategic firebreaks. EcoFire aims to restore biodiversity, pastoral and cultural values by reducing the incidence of late dry season fires in the central and north Kimberley. The West Kimberley Nature Project works with Traditional Owners and Kimberley Land Council-facilitated Indigenous ranger groups to sustainably manage wildfires and control weeds to protect and conserve the Dampier Monsoon Vine Thickets and wetlands on the Dampier Peninsula (Envirosearch, 2011c).

Invasive species

The ecological community provides habitat for a diverse range of native animal and plant species. Although pastoral operations on the Dampier Peninsula are no longer operating, former domesticated animals are still present in the region as ferals and evidence of their impacts has been recorded in a number of patches of the ecological community.

Vertebrates

Feral cattle (*Bos* sp.) have been recorded in 39% of surveyed patches of the ecological community where they browse the understorey and break branches (Black et al., 2010) and pigs (*Sus scrofa*) graze, deposit dung, disturb the soil and damage flora. These impacts can result in a loss of structural integrity in patches of the ecological community mostly due to an opening of the canopy and introduction of seeds from invasive species. Further, where invasive species are fire tolerant, the ecological community may be more susceptible to fire damage.

Feral cats (*Felis catus*) and dogs (*Canis lupus familiaris*) can prey on native fauna that utilise the ecological community, particularly reptiles, ground dwelling mammals and birds. Bird species that forage, nest and roost on or near the ground are highly susceptible to predation by feral cats.

Cane toads are known to occur in northeastern Kimberley at Lake Argyle. While not currently detected on the Dampier Peninsula, this invasive species has the potential to displace or cause the decline of many native species within the ecological community, such as amphibians, mammals and reptiles.

Invertebrates

Introduced ant species aggressively compete with native animal species and have the potential to eliminate many native species and seriously disrupt ecological processes and alter food availability for native species. The invasive black crazy ant (*Paratrechina longicornis*) and Singapore ant (*Monomorium destructor*) have been recorded within the ecological community. These species are aggressive invaders and can reduce invertebrate species diversity and displace species such as the green tree ant (*Oecophylla smaragdina*). Invasive ants can cultivate sap-sucking insects such as scale and aphids, using the honeydew produced by these pests as a food source. They protect these insect pests from attack by natural predators, potentially leading to pest outbreaks that weaken host plants (CSIRO, 2010, 2011; Environs Kimberley, 2011b)

Weeds

Approximately 60% of the Dampier Monsoon Vine Thicket patches surveyed by Black et al. (2010) contained environmental weed species, although the degree of infestation varied with each patch. Most weed occurrences were on the edge of patches or where the canopy had been disturbed. Many of the major weed species impacting the ecological community (Appendix B, Table B3) originated from pastoral and horticultural species e.g. pie melon (*Citrullus lanatus*).

Through competition for space and resources, invasion by weeds can displace native species and reduce native plant abundance and diversity. It can also transform the vegetation structure of an ecological community. The introduced buffel grass (*Cenchrus ciliaris*) is common on the Dampier Peninsula and it occurs in approximately 30% of patches of the ecological community. Buffel grass can cause changes in fire regimes, as it is fire tolerant and can induce a 'grass-fire cycle'. The grass-fire cycle occurs when flammable invasive grasses establish and lead to an increased fire frequency and, in some cases, intensity. This causes a decline in tree and shrub cover, facilitating further grass invasion, which in turn increases the likelihood of further fires (NT Government, 2006, 2010).

The Dampier Monsoon Vine Thickets occurs adjacent to the urban areas of Broome, Lombadina-Djarindjin and One Arm Point where many invasive weeds, such as the yellow poinciana tree (*Peltophorum pterocarpum*) and neem tree (*Azadirachta indica*) are planted or have established. Disturbances to sites, feral animals, birds and macropods, are likely dispersal vectors for weed species. Minor earth works or soil disturbance such as creation or maintenance of access roads or the use of heavy machinery can lead to the germination of weeds in or near to the ecological community. For example, coffee bush (*Leucaena leucocephala*) has germinated in a number of patches near disturbed areas at James Price Point and siratro (*Macroptilium atropurpureum*) at Yawuru Conservation Park in Broome. Although not currently recorded in the ecological community, other highly invasive weeds are known to occur nearby. For example, rubber vine (*Cryptostegia madagascariensis*), a Weed of National Significance (WoNS), occurs at Lombadina-Djarindjin, while lantana (*Lantana camara*), another WoNS, is present at Beagle Bay and One Arm Point.

Introduced vines and climbers such as hairy morning glory (*Merremia dissecta*) and snakeweed (*Stachytarpheta cayennensis*) can penetrate the overstorey of the ecological community where they compete with existing native vine species and smother underlying native flora species. Other weed infestations can also act as fire paths during drought. Exotic creepers and vines such as butterfly pea (*Clitoria ternatea*) and wild passion fruit (*Passiflora foetida*) can smother

trees on rainforest boundaries that have been degraded by various impacts including fire (Russell-Smith and Bowman, 1992). When desiccated, these vines can wick fire into the canopy (Panton, 1993). Shrub species such as horehound (*Hyptis suaveolens*) have also been associated with rainforests damaged by fire.

Altered hydrology

The ecological community may be impacted by development that alters localised hydrology, microclimates and precipitation or where there is alteration to aquifer levels or quality.

Stormwater runoff from formed and sealed roads can create concentrated flows. This can lead to erosion and increased local flooding. Flora species within the ecological community that do not readily adapt to changed drainage regimes, such as the overstorey species *Gyrocarpus americanus* (helicopter tree), can decline or die from extended periods of submersion. Runoff from suburban sources is also a vector for weed invasion, increased nutrient loads and rubbish deposition.

After rain, water accumulates in the dune swale habitat of the ecological community and contributes to the recharge of aquifers. The creation of hardstand areas and use of groundwater for development will potentially alter surface flows and lower groundwater levels, reducing water availability for vegetation. Any change to hydrological inputs may affect the trees within the ecological community.

Climate Change

Climate change is now understood to pose a serious long-term threat to terrestrial, coastal and aquatic ecosystems and to have the potential to change the ecology of these environments. Not only does climate change directly threaten species that cannot adapt, it could also exacerbate existing threats, including loss of habitat, altered hydrological regimes, altered fire regimes, and invasive species. The potential large-scale impacts of climate change could influence the species composition of this ecological community through their responses to disturbance and the very nature of those disturbances.

As a consequence of greenhouse gas-induced global warming, trends suggest northern Western Australia will become warmer with more hot days and fewer cold nights (CSIRO and Bureau of Meteorology, 2007). By 2030 the annual average number of days over 35°C in Broome could grow from the current 54 to 64–119 days. A small decline in annual rainfall and a decrease in relative humidity are also expected. Trends suggest that evapotranspiration, ignition of fires due to lightning strike and frequency of severe cyclones may increase.

The modelled impacts of climate change on temperature, rainfall and the severity and frequency of extreme weather events are likely to directly affect the hydrological and fire regimes that impact on the nature and persistence of the ecological community. The Dampier Monsoon Vine Thickets will be particularly vulnerable to extended dry periods with associated desiccation of plant fuels and resultant likely increased fire risk.

Key threatening processes

The following EPBC Act listed Key Threatening Processes are considered relevant to the Monsoon vine thickets on the coastal sand dunes of Dampier Peninsula ecological community:

- Invasion of northern Australia by gamba grass and other introduced grasses
- Land clearance
- Loss of terrestrial climatic habitat caused by anthropogenic emissions of greenhouse gases
- Predation, Habitat Degradation, Competition and Disease Transmission by Feral Pigs
- The biological effects, including lethal toxic ingestion, caused by cane toads (*Bufo rhinella marinus*)

Appendix F – Eligibility for listing against the EPBC Act criteria

This Appendix presents the detailed analysis relevant to the listing criteria in regard to the Dampier Monsoon Vine Thickets.

Criterion 1 - Decline in geographic distribution

The Dampier Monsoon Vine Thickets occurs as naturally fragmented patches from Broome in the southwest, to One Arm Point in the north, to Goodenough Bay in the south east of the Dampier Peninsula. It occurs in coastal to near-coastal sites that are favourable for the development of vine thicket communities.

While there has been no detailed modelling of the likely pre-European distribution of the ecological community, it has been estimated that the ecological community formerly occupied up to 2800 ha (Black et al., 2010; DEC, unpublished).

The current extent of the ecological community is estimated to range from 2300 to 2685 ha, based on recent vegetation surveys (Black et al., 2010; DEC, unpublished).

It should be noted that these estimates do not take the condition criteria prescribed earlier into account so it is likely that the extent which remains in good condition is less than these estimates. These estimates also do not take future development interests in this region into account. There is the potential for further loss of the ecological community from future development.

The known decline in extent of the ecological community is in the order of 4–18% and is likely to be <30%, even if condition and potential imminent projects are taken into account. This is well below the minimum 70% indicative threshold for the substantial decline of an ecological community.

The ecological community has not undergone a significant decline in its geographic distribution. Therefore, the ecological community is **not eligible** for listing in any category under this criterion.

Criterion 2 - Small geographic distribution coupled with demonstrable threat

This criterion aims to identify ecological communities that are geographically restricted to some extent. Three indicative measures apply: 1) extent of occurrence (i.e. the total geographic range of the ecological community); 2) area of occupancy (i.e. the area actually occupied by the ecological community within its natural range); and 3) patch size distribution, which is indicative of the degree of fragmentation. It is recognised that an ecological community with a distribution that is small, either naturally or that has become so through modification, has an inherently higher risk of extinction if it continues to be subject to ongoing threats that may cause it to be lost in the future. There are demonstrable and ongoing threats to the Dampier Monsoon Vine Thickets, as detailed in Appendix E.

Extent of occurrence

The ecological community is generally scattered across the coastal and near-coastal parts of the Dampier Peninsula. The extent of occurrence roughly equates to about 194 700 ha. An extent of occurrence that lies within the range 100 000 to <1 million ha is indicative of a limited geographic distribution.

Area of occupancy

The ecological community is estimated to occupy a total area of approximately 2300–2685 ha (Black et al., 2010; DEC, unpublished). It is likely that the extent, which remains in good condition is marginally less than these estimates. An area of occupancy within the range 1000 to <10 000 ha is indicative of a restricted geographic distribution.

Patch size distribution

Of the 77 known patches of the ecological community 28 (or 36%) are less than 10 ha in size. In addition, the majority (72 patches or 94% of the total known) are less than 100 ha in size (based on analysis of data from DEC, unpublished). This indicates the ecological community generally occurs as fragmented, small patches, which is consistent with a restricted geographic distribution. The fragmentation of the ecological community is largely natural, rather than a consequence of disturbance, and is due to the patchy nature of landscape positions suitable for the development of the Dampier Monsoon Vine Thickets.

Fragmented ecological communities are likely to be more susceptible to disturbances and adverse influences from the surrounding environment. This happens regardless of whether fragmentation arises naturally or from landscape modification and disturbance. The degree of fragmentation, in itself, is not indicative of a reduction in community integrity for the Dampier Monsoon Vine Thickets, but simply reflects the ecological community's natural distribution. However, the degree of fragmentation may influence how the ecological community responds to a threat, its resilience to a particular disturbance and, therefore, the degree to which reduction in community integrity is expressed. The relevant consideration therefore is not fragmentation but the nature of continuing degradation to these fragmented patches.

The ecological community has a restricted distribution, on the basis of its fragmented patch sizes and area of occupancy. It is subject to a range of ongoing threats, described in Appendix E, which could cause it to be further degraded or lost in the medium-term future. Therefore, the ecological community has been demonstrated to meet the relevant elements of Criterion 2 to make it **eligible** for listing as **vulnerable**.

Criterion 3 - Loss or decline of functionally important species

The closed canopy of the Dampier Monsoon Vine Thickets generally provides shelter and habitat for a range of species, both plant and animal, that require more moisture and shade than is available from more open surrounding vegetation communities. It can generally be surmised that particular species or guilds of species would have important roles for maintaining ecosystem function in the ecological community. For instance, frugivorous birds and mammals are known to be important for seed dispersal of key canopy forming trees, such as ebony wood, coffee fruit, mamajen, mangarr and wild apple (Kenneally et al., 1996). Other shrub and vine species, such as goolyi, provide important resources for small birds. However, the specific functional roles and importance of species for this ecological community are not known in detail. Furthermore, despite known threats impacting upon species within the Dampier Monsoon Vine Thickets, no data are available to show that these particular functional species are in decline. For example, none of the key canopy species are listed as threatened in their own right.

There are insufficient data available to determine the ecological roles, or the loss or decline of functionally important species within the ecological community. Therefore, the ecological community is **not eligible** for listing in any category under this criterion.

Criterion 4 - Reduction in community integrity

The Dampier Monsoon Vine Thickets is a naturally fragmented ecological community that occurs as individual patches or groups of patches within the swales and the lee of the coastal Holocene dune systems that run parallel along the coastline of the Dampier Peninsula. Individual patches and patch groups operate as an ecological network, with connectivity being maintained by dispersal vectors, particularly bird and mammal frugivorous species (Black et al., 2010). Seventy-seven patches of the ecological

community currently are known to occur. Many of these patches are linear and narrow, have a high edge to area ratio, and are small with the majority being <100 ha in size.

A number of factors potentially contribute to the degradation of the ecological community, however, altered fire regimes and invasive weeds are two factors in particular that are reducing the integrity of the ecological community. The factors do not necessarily act in isolation but may be interactive or synergistic in their cumulative impacts to the ecological community.

Reduction in integrity through altered fire regimes

The key structural elements of the Dampier Monsoon Vine Thickets include a typically closed tree canopy cover over a relatively moist understorey that confers some natural resistance to fire spreading into intact patches. This contrasts with the surrounding or nearby vegetation that is often more open, drier and flammable, for instance pindan.

Traditional fire regimes in the Kimberley region likely consisted of patchwork fires. Little is known in detail of particular fire regimes but burning patches of rainforest/vine thickets and their immediate surrounds generally appears to have been deliberately avoided. This helped to preserve vine thickets as a food resource, due to the diversity of fruit bearing trees present in the ecological community. However, fire regimes have changed from traditional Indigenous management to mostly uncontrolled annual fires ignited by natural and anthropogenic causes. In general, there are now larger and more frequent fires across the Dampier Peninsula.

The impacts of these changed fire regimes to the ecological community have been monitored at least since 1989, with detailed data from 2000 to 2010 (Fisher et al., unpublished). The data collected include the frequency and area of the Dampier Monsoon Vine Thickets affected by fire for 70 of the 77 known patches, and show that the incidence of fire in the ecological community has increased markedly in the preceding decade (Table F1).

- Only two of the 70 patches were not burnt at all in the period from 2000 to 2010 inclusive. The remainder experienced at least one fire in the patch. A few patches were burnt, to some extent, each year or almost every year. The median number of fires per patch over the decade was 4.5.
- The median total area burnt per patch was about 10 ha. Individual fires burnt a median area of 2 ha per patch.
- If it is assumed that there were minimal occasions when successive fires burnt the same parts of a patch, the total area burnt within the decade amounted to almost 1800 ha or two-thirds of the total extent of the 70 patches of the ecological community that were monitored. Even if this value overestimates the total amount burnt over the decade, the data indicate that the ecological community is impacted by fire and that fire recurs at repeated, sometimes short, intervals.

Table F1. Frequency of fires on the Monsoon Vine Thickets of the Dampier Peninsula ecological community between 2000 to 2010, inclusive (Fisher et al., unpublished) (Number of patches monitored = 70; total area of patches = 2660 ha)

A) Frequency of fires in the ecological community

Fire Frequency (years)	0	1	2	3	4	5	6	7	8	9	10	11
Number of patches	2	5	10	11	6	12	6	3	10	3	1	1
% of patches	2.9	7.1	14.3	15.7	8.6	17.1	8.6	4.3	14.3	4.3	1.4	1.4

B) Area of the ecological community burnt per year

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total *
Area burnt (ha)	84.7	348.2	94.1	77.8	80.7	243.5	22.6	202.5	159.4	431.7	51.7	1796.9
Area burnt (%)	3.2	13.1	3.5	2.9	3.0	9.2	0.8	7.6	6.0	16.2	1.9	67.6

* Assumes no substantial overlap in the area burnt by recurring fires, i.e. that the part of a patch previously burnt was not burnt again during the successive fire(s).

Many plant species that occur in the Dampier Monsoon Vine Thickets are fire sensitive and do not recover well after fire. An increase in the frequency and intensity of fires therefore can lead to a loss in the diversity of these elements of the ecological community. The impacts of fire on patches of the Dampier Monsoon Vine Thicket also include a reduction in the cover of trees, shrubs and vines and loss of accumulated ground litter. This opening of the vegetation structure and the ground layer allows invasive grasses to establish into the ecological community through burnt areas (discussed in the following section). Grasses are a minor floristic component in undisturbed patches of the Dampier Monsoon Vine Thickets.

Observations show that fire usually affects the edges of a patch more frequently than its core (Fisher et al., unpublished). This has particularly adverse affects on the Dampier Monsoon Vine Thickets because many patches are narrow and linear with large edge to area ratios. Consequently, successive fires lead to progressive degradation at the edges and greater exposure of the core of a patch to subsequent disturbances. Fisher et al. (unpublished) noted changes in the vegetation structure and increased cover of invasive grasses, particularly along the edges of a patch, following frequent fire.

The ecological community is impacted more by late dry season fires than early to mid dry season fires. Late dry season fires are likely to be more intense due to the increased dryness and flammability of the vegetation.

Reduction in integrity through weed invasion

Weed invasion is an ongoing threat that contributes to the degradation of the Dampier Monsoon Vine Thickets. The worst weeds are able to spread into relatively intact patches of native vegetation, while other species establish after some form of disturbance. Once established they adversely affect native species through direct competition or by altering ecosystem processes, such as disrupting food webs or

dispersal agents (as when natural pollinators visit weed rather than native species) or changing fire regimes (for instance the establishment of more flammable invasive grass species into a patch).

Given the broad extent of the ecological community, the number of invasive weed species threatening the ecological community is potentially large. Certain weed species are likely to have more serious adverse impacts on the ecological community than others. For example, neem (*Azadirachta indica*) and coffee bush (*Leucaena leucocephala*) displace native canopy forming trees and form impenetrable thickets. Neem is a relatively recent weed introduction (Barrett, pers. comm., 2012) that is mainly dispersed by birds that eat its fruit. *Passiflora foetida* (passion vine) is also spread by birds and bats and can invade areas that have not been subject to other disturbances. Climbers such as siratro (*Macropodium atropurpureum*), hairy morning glory (*Merremia dissecta*) and Darwin pea (*Clitoria ternatea*) are vigorous climbers that cover trees and shrubs, particularly on the edge of a patch or in other disturbed areas of the ecological community. These species have the potential to displace native vine species and to dominate the canopy of native trees species. When they desiccate, they can provide a vector for fires into the canopy of the ecological community. Shrubby weeds such as horehound (*Hyptis suaveolens*) can outcompete native species and dominate groundcover, particularly where the canopy is open such as at the edges of the ecological community.

There is evidence that the incidence of weeds in the ecological community is relatively high. Black et al (2010) recorded weeds to be present in approximately 60% of patches of the Dampier Monsoon Vine Thickets. In particular, serious weeds such as passion vine occur in about 40% of patches, buffel grass (*Cenchrus* spp.) in about 30% of patches, neem in 14% of patches, sirato in about 12% of patches and coffee bush in about 9% of patches (Louise Beames pers. com., 2012).

Weeds that were introduced as pasture species, such as buffel grass, occur in surrounding vegetation communities from which they spread into the ecological community, given appropriate disturbance or vectors. Buffel grass can penetrate the ecological community via human and animal tracks or by disturbances, such as fire (Black et al., 2010; Australian Weeds Committee, 2012). It is recognised to be highly invasive and its rapid growth can displace native species within the ecological community. Buffel grass also is tolerant of fire and can significantly increase fire fuel loads where it has established on the edge or within patches of the ecological community. This contributes to a change in the fire regime of a patch by promoting the spread of fires into the ecological community.

Degradation due to weeds can be ongoing if not appropriately managed. A number of weed identification and management programs are being conducted in the ecological community by state and local government bodies, community and NRM groups, and Indigenous ranger groups. However, these programs are not currently widespread and the effective long-term management of weeds is often resource intensive and requires considerable commitment and effort. Many of the weeds now present in the ecological community are established and likely to spread further, being highly invasive. They are contributing to a reduction in integrity of the ecological community and their impacts can be exacerbated by the changes to fire regimes noted above. The nature of the existing weed problem and the difficulties of implementing consistent management across the region, mean that weeds will continue to contribute to a reduction in integrity of the ecological community into the future.

Reduction in integrity through other disturbances, e.g. invasive pest animals

Altered fire regimes and weed invasions are key factors that are reducing the integrity of the Dampier Monsoon Vine Thickets but other disturbances also contribute. Pastoral activity formerly occurred on the Dampier Peninsula but has since declined and much of the land has been destocked. However, feral populations of domestic stock, notably cattle, donkeys and pigs occur in the region. Feral animals can damage the ecological community by removing canopy plants establishing in the understorey, opening up thickets, destroying soil structure by trampling and digging. These activities help to spread weeds into thickets and, in so doing, increase the susceptibility of patches to fire and erosion. Further, they reduce the ability of native plant species to regenerate, thereby limiting the capability of the ecological community to recover from disturbance.

Other feral animals that occur in or near to the ecological community are predators and omnivores that impact upon native fauna either by direct predation or competition for resources. For instance, black rats have been noted in vine thickets (McKenzie, 1991); feral cat tracks have been observed frequently in dune systems that occur around the Dampier Monsoon Vine Thickets; and feral dogs are often reported near outstations and tip points in the region (L. Beames, pers. comm., 2012). Introduced ant species such as the black crazy ant (*Paratrechina longicornis*) have been recorded within the ecological community and can displace species such as the green tree ant (*Oecophylla smaragdina*) (CSIRO, 2010, 2011; Environs Kimberley, 2011b).

The degree of impact on the ecological community from grazing and other activities by feral animals has not been quantified. However, there is some evidence on the incidence of feral activities within patches of the ecological community. Black et al. (2010) noted impacts due to feral cattle in 24 (or 39%) of the 62 occurrences surveyed and impacts due to feral pigs in two occurrences.

In addition to the impacts from feral animals, there also are human impacts to patches, particularly those close to larger settlements, such as Broome. Impacts include dumping of rubbish in or near to remnants, and the creation of access tracks and gaps in or at the edges and cores of remnants, including from 4WD vehicles driving off-road on dune systems.

Summary

A number of threats operate on the Dampier Monsoon Vine Thickets that adversely affect the integrity of the ecological community. There are clear adverse impacts from altered fire regimes that have led to increased frequency and intensity of burn, but also various impacts due to weed invasion, feral animals and human activities. These impacts are exacerbated by the naturally fragmented nature and restricted distribution in the landscape of the Dampier Monsoon Vine Thickets. All these actions operate in conjunction with likely synergistic detrimental impacts. If this is ongoing, the integrity of the ecological community and its capacity for restoration from disturbance will continue to decline over time.

Based on the evidence presented above, the reduction in integrity experienced by the ecological community is severe and that indicates a severe degradation and disruption to community processes. Therefore, the ecological community is **eligible** for listing as **endangered** under this criterion.

Criterion 5 - Rate of continuing detrimental change

There are no quantitative data available to assess this ecological community under this criterion. Therefore, it is **not eligible** for listing under this criterion.

Criterion 6 - Quantitative analysis showing probability of extinction

There are no quantitative data available to assess this ecological community under this criterion. Therefore, it is **not eligible** for listing under this criterion.

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