National recovery plan for the yellow-bellied glider (Wet Tropics) *Petaurus australis* unnamed subspecies

Queensland Government

Australian Government

Title: National recovery plan for the yellow-bellied glider (Wet Tropics) *Petaurus australis* unnamed subspecies

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Publication reference:
Department of Environment and Resource Management 2011. National recovery plan for the yellow-bellied glider (Wet Tropics) *Petaurus australis* unnamed subspecies. Report to Department of Sustainability, Environment, Water, Population and Communities, Canberra. Department of Environment and Resource Management, Brisbane.

Contents

Executive Summary

Species status

The yellow-bellied glider (Wet Tropics) *Petaurus australis* unnamed subspecies, is a nocturnal gliding marsupial. It is listed as 'Vulnerable' under both the Queensland *Nature Conservation Act 1992* and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. The yellow-bellied glider (Wet Tropics) has been referred to previously as *Petaurus australis reginae* but is now more correctly known as *Petaurus australis* unnamed subspecies.

Habitat and distribution

The yellow-bellied glider (Wet Tropics) is largely restricted to the narrow band of wet eucalypt open forest (also called wet sclerophyll forest) that is an ecotone between rainforest and drier woodland ecosystems. This habitat provides the two key habitat resources, den trees (principally rose gum *Eucalyptus grandis*) and sap feed trees (red mahogany *Eucalyptus resinifera* – locally known as red stringybark). The diet is highly varied but sap represents a major food source.

The yellow-bellied glider (Wet Tropics) is found in the Wet Tropics Bioregion of Queensland. The current distribution remains similar to its likely distribution prior to European settlement. The range is between Yamanie Creek catchment (70 km west of Cardwell) and Mt Windsor Tableland (100 km north-west of Cairns), a distance of around 260 km. There are three major subpopulations:

(1) the Cardwell Range - Herberton Range subpopulation occurs over 130 km
(2) the Mt Carbine Tableland subpopulation occurs over 25 km
(3) the Mt Windsor Tableland subpopulation occurs over 20 km

Threats summary

Several threats are affecting the survival of yellow-bellied gliders (Wet Tropics). The threats principally relate to habitat alteration and fragmentation. In order of likely significance these are:

- changed vegetation structure due to change in fire regime and other factors (major)
- clearing and fragmentation of habitat (moderate)
- grazing regime (minor)
- barbed wire fencing (minor)
- climate change (unknown)

Recovery objective

To manage the impact of threatening processes on yellow-bellied gliders (Wet Tropics) to protect and recover populations throughout their range.

Actions summary

- Define essential habitat distribution
- Implement adaptive fire management
- Protect and manage habitat outside protected area estate and regenerate habitat corridors
- Research the impacts of cattle on glider habitat
- Collate existing data on glider barbed wire incidents and establish a reporting process through WildNet.
- Analyse glider and barbed wire incident data to establish level of impact and identify potential hotspot locations for targeted management.
- Implement an extension program for landholders on appropriate grazing regimes and fencing modification in glider habitat
- Undertake monitoring programs to assess the number of gliders in known habitat
- Analyse genetic structure of glider populations
- Improve understanding of climate change impacts

1. General information

Conservation Status

The yellow-bellied glider (Wet Tropics) is listed as 'Vulnerable' under both the Queensland *Nature Conservation Act 1992* (NCA) and the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). IUCN (International Union for the Conservation of Nature) does not specifically refer to yellow-bellied glider (Wet Tropics), but lists *Petaurus australis* (all yellow-bellied glider populations) as 'Low Risk (near threatened)'.

International obligations

The yellow-bellied glider (Wet Tropics) is not listed under any international agreements. However, actions described in this plan are consistent with Australia's international obligations.

Affected interests

The majority (over 80%) of yellow-bellied glider (Wet Tropics) habitat is reserved for nature conservation and is managed by the Department of Environment and Resource Management (DERM), including habitat within the Wet Tropics World Heritage Area (WTWHA). Some existing and former habitat (especially cleared habitat) occurs on private land and land managed by the Queensland Department of Employment, Economic Development and Innovation (DEEDI).

The species occurs on land tenures owned or managed by authorities and landholders including:

- DERM (including unallocated state land and protected areas estate)
- DEEDI
- Wet Tropics Management Authority (WTMA)
- Powerlink and Ergon
- Cook Shire Council and Cairns, Tablelands and Cassowary Coast regional councils
- Traditional Owners for Kirrama Station
- Australian Wildlife Conservancy (AWC) – landholder of 'Brooklyn' property north of Mt Molloy
- Private landholders especially in the Herberton-Ravenshoe area

Other organisations with management interest include:

- Australian Government Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC)
- Terrain Natural Resource Management (Terrain NRM)
- Aboriginal communities, councils and representative bodies such as Aboriginal Rainforest Council (ARC and Girringun Aboriginal Corporation (GAC)
- Peak conservation groups such as Wildlife Preservation Society of Queensland (WPSQ), Bush Heritage Australia (BHA), Cairns and Far North Queensland Environment Centre
- Community conservation groups such as Trees for the Evelyn and Atherton Tableland (TREAT) and Tree Kangaroo and Mammal Group (TKMG), Tolga Bat Hospital.
- Scientific research institutions including CSIRO Sustainable Ecosystems and James Cook University (JCU)

Consultation with Indigenous people

Implementation of the plan's actions includes consideration of the role and interests of Indigenous people in yellow-bellied glider (Wet Tropics) conservation. Traditional Owners and their representative organisations including the Aboriginal Rainforest Council (ARC) and Girringun Aboriginal Corporation (GAC) were consulted during the plan's development and will continue to be encouraged to participate during implementation,

including on issues such as fire management and activities and monitoring on Native Title lands.

Benefits to other species or communities

The yellow-bellied glider (Wet Tropics) is considered an iconic or flagship species within the wet eucalypt open forest habitat. Management actions focusing on the yellow-bellied glider (Wet Tropics) will assist the conservation of other species associated with this restricted habitat type, including the northern bettong *Bettongia tropica* (Table 1). This habitat includes four regional ecosystems of conservation significance (Table 2).

The glider has an important function in the ecosystem due to its role supporting a 'sap-feeding guild' and possibly as a pollinator, although there are few data available to support the latter. Chapman et al. (1999) list fauna that are known to use the sap resource 'tapped' by the glider, including nocturnal arboreal marsupials and a range of diurnal birds and invertebrates. The sap may be eaten directly, or prey attracted to the sap resource may be captured.

The habitat types that support the glider are at their northern distribution limit in the Wet Tropics Bioregion. Consequently several fauna species which occur in yellow-bellied glider (Wet Tropics) habitat are also approaching their northern distribution limit. Whilst many of these species are not formally listed as threatened, they may be locally threatened by the disappearance of their preferred/dependent habitat.

Table 1: Species of conservation interest associated with yellow-bellied glider (Wet Tropics) habitat.

Species	Scientific name	Conservation status	
		NCA [1]	EPBC [2]
northern bettong	*Bettongia tropica*	Endangered	Endangered
magnificent broodfrog	*Pseudophryne covacevichae*	Vulnerable	Vulnerable
Shrub	*Dodonaea uncinata*	Near threatened	
Shrub	*Prostanthera clotteniana* (formerly *Hemigenia clotteniana)*	Endangered	Extinct

1. Queensland *Nature Conservation Act 1992*
2. Australian Government *Environment Protection and Biodiversity Conservation Act 1999*

Fires can play an important role in maintaining moist, open woodland for the yellow-bellied glider (Wet Tropics). Thicker, denser structure of a closed forest is thought to impede the passage of the yellow-bellied glider (Wet Tropics), largely negating the competitive advantage of gliding (M. Parsons, pers. comm. 2011). The recovery plan contains actions to maintain wet eucalypt open forest for the yellow-bellied glider (Wet Tropics) through prescribed burning which, in turn, may also provide benefits to other species associated with these ecosystems.

Table 2: Ecosystems of conservation interest associated with yellow-bellied glider (Wet Tropics) habitat.

Regional ecosystems	Description	Status	
		VMA [1]	REDD [2]
RE 7.8.15	*Eucalyptus grandis* open forest to woodland (or vine forest with *E. grandis* emergents), on basalt	Of concern	Endangered
RE 7.8.16	*Eucalyptus resinifera* open forest to woodland on basalt	Of concern	Endangered
RE 7.12.21	*Eucalyptus grandis* open forest to woodland, or *Corymbia intermedia*, *E. pellita*, and *E. grandis*, open forest to woodland, (or vine forest with these species as emergents), on granites and rhyolites.	Least concern	Endangered
RE 7.12.22	*Eucalyptus resinifera* +/- *Eucalyptus acmenoides* +/- *Syncarpia glomulifera* tall open forest to tall woodland (or vine forest with these species as emergents), on moist to wet granite and rhyolite uplands and highlands.	Least concern	Endangered

1. Queensland *Vegetation Management Act 1999*
2. Regional Ecosystems Description Database version 5.0, Environmental Protection Agency 2007 (Biodiversity status)

Social and economic impacts

This recovery plan does not include any actions that are likely to cause any significant adverse social or economic impacts. The plan does not impose any habitat protection measures for wet eucalypt open forest on private land. The *Vegetation Management Act 1999* (VMA), in conjunction with the *Sustainable Planning Act 2009* (SPA) and local government planning schemes, largely determine what clearing is permissible on private property. While conservation of habitat on private land will be encouraged, such actions by landholders are voluntary. Landholders are encouraged to consider the monetary (possible tax concessions versus potential loss of future options) and non-monetary benefits of entering into 'voluntary conservation agreements'. Planning and implementing fire management strategies on conservation land adjacent to neighbouring tenures will need to be conducted in a consultative manner with consideration for private assets.

Successful recovery efforts will have positive social, economic and educational impacts. The yellow-bellied glider (Wet Tropics) is considered a flagship animal for Wet Tropics wet eucalypt open forest. Communities are likely to benefit via continued tourism associated with spotlighting tours and other activities that appreciate the unique forest types occupied by the glider.

2. Biological information

Species description

The yellow-bellied glider (Wet Tropics) is a nocturnal and arboreal gliding marsupial. Glides over 100 m have been recorded by adults departing from tall trees and travelling downslope. Adults typically weigh 500 g (Russell 1984). The head-body length is around 300 mm, and the tail is around 450 mm long (Russell 2002). Compared with the more widespread southeast Australian populations, the Wet Tropics population is smaller and lighter in weight (Russell 1984) and may be darker in colour on the back. Goldingay et al. (2001) suggest that the reported whitish rather than yellowish belly is a function of age, with belly colour tending to yellow with increasing age. Yellow-bellied gliders produce distinctive and loud shrieking and gurgling calls (Russell 1984, Lindenmayer 2002).

There has been confusion surrounding the taxonomy and use of scientific names associated with yellow-bellied gliders. The Wet Tropics population is disjunct from the

main southeast Australian populations (there is a gap of around 400 km between the Mackay area populations and the Wet Tropics population), and is usually treated as distinct based on its distribution, morphology and ecology. The EPBC Act refers to 'Yellow-bellied glider (Wet Tropics), *Petaurus australis* unnamed subspecies'. The Queensland *Nature Conservation Act 1992* refers to 'Yellow-bellied glider (northern subspecies), *Petaurus australis* unnamed subsp.'. The *Action Plan for Australian Marsupials and Monotremes* (Maxwell et al. 1996) refers to *Petaurus australis* unnamed subsp. and uses two common names, fluffy glider and yellow-bellied glider (northern subspecies). It is clear that all are referring to the same population.

The name *Petaurus australis reginae* is now generally regarded as inappropriate for the geographically isolated Wet Tropics population. Designation of the subspecies was based on differences in fur colour. Further studies indicated that the colour of the belly fur varies according to the age of the individual and cast doubt on this distinction (Goldingay & Kavanagh 1990; Goldingay et al. 2001). Furthermore, the type specimen for the subspecies *reginae* was from a southern population (near Bundaberg) and not from the north Queensland (Wet Tropics) population. Genetic analysis and ecological differences indicate that the Wet Tropics population is an evolutionary significant unit (ESU), distinct from southern Australian populations (Brown et al. 2006). The results of this study are consistent with the recognition of the northern Queensland population as a distinct subspecies. Little information has been published comparing yellow-bellied glider populations throughout the entire range.

The naming protocol implemented by the EPBC Act (yellow-bellied glider (Wet Tropics), *Petaurus australis* unnamed subsp.) appears an appropriate working solution until taxonomic issues are clarified. While the succinct common name of 'fluffy glider' for Wet Tropics population of yellow-bellied gliders has often been used, it has not been adopted as the 'official' common name, and unless the Wet Tropics population is formally described as distinct, will probably remain a local name.

Life history and ecology

The yellow-bellied glider (Wet Tropics) is largely restricted to the narrow band of wet eucalypt open forest (also called wet sclerophyll forest) that provides its two key habitat resources, den trees and sap trees. Den trees, used for daytime shelter and by young animals, are primarily hollow-bearing rose gum *Eucalyptus grandis* (also referred to as flooded gum). A major food source is sap, almost exclusively from red mahogany *E. resinifera* (also referred to locally as red stringybark) (Quin et al. 1996). In contrast, southern populations of yellow-bellied gliders consume the sap of numerous tree species (e.g. Eyre & Goldingay 2005). A small number of select red mahogany trees within the home range are used for sap feeding, by chewing and chiselling through bark to access sap flow. This leads to distinctive scarring on the trunk of the trees. Other food sources include other exudates (especially nectar but also honeydew and manna), pollen and invertebrates. In north Queensland, yellow-bellied gliders are known to feed extensively on nectar and pollen of *Banksia integrifolia* during autumn and winter (Quin et al. 1996).

The wet eucalypt forest habitat occurs between rainforest and dry sclerophyll forest (open forest and woodland), at 600-1300 m a.s.l. (Winter 1997a). The habitat is often very narrow (usually less than 4 km wide and sometimes no more than two trees wide) and subject to fragmentation and deterioration from natural and human land management processes. Creation of gaps and clearings such as roads and easement corridors can isolate populations, fragment habitat and increase the risk of predation. For the Southern yellow-bellied glider, gaps in excess of 50 metres can act as dispersal barriers. Den trees are usually exceptionally large live rose gum *Eucalyptus grandis*. The preference for rose gum may relate to the presence of larger hollows that can accommodate entire social groups (R. Goldingay, pers. comm. 2007). It may also be related to reduced competition from possums for dens or reduced predation from goannas and pythons due to the smooth bark of the rose gums that makes them difficult to climb (R. Russell, pers. comm.

2007). More than one den may be used by a group. Sap feed trees are almost exclusively red mahogany (R. Russell, pers. comm. 2007). Goldingay & Quin (2004) found that gliders studied at Nitchaga, south of Ravenshoe usually used two feed trees in a territory at any given time and around five feed trees may be used over a year. Other scarred trees may occur nearby but remain unused.

Births occur throughout the year. The single young spends around 100 days in the pouch, and a further 50 days in the den before making forays outside the den, initially by clambering and jumping between branches rather than gliding. The glider lives in family groups of 2-6 individuals, which typically occupy exclusive home ranges averaging around 50 ha, but much smaller territory sizes were recorded by Russell (1984). Individuals may travel up to 1 km between den and feed trees. Group and home range size are probably related to habitat quality. Goldingay et al. (2001) studied gliders at Nitchaga, south of Ravenshoe and found that they had a highly variable social system. Lifespan is known to be at least six years (Russell 1984). Goldingay et al. (2001) also found that although gliders at Nitchaga where born throughout the year, the majority were born between June and late August.

Distribution

The current distribution of yellow-bellied gliders (Wet Tropics) remains relatively similar to that assumed to have occurred prior to European settlement, with the exception of areas where habitat clearing has occurred. The range is between Yamanie Creek catchment, just north of the Herbert River Gorge (70 km west of Cardwell) and Mt Windsor Tableland (100 km north-west of Cairns) (Winter 1997a), a distance of around 260 km (Figure 1 and Figure 2).

Three major subpopulations are identified (Maxwell et al. 1996):

(1) The Cardwell Range - Herberton Range subpopulation occurs patchily from near Atherton south to the Herbert River. This subpopulation has a narrow linear distribution 120 km long, rarely wider than 2 km and is expected to be naturally fragmented due to habitat discontinuities, particularly in the south. In addition, habitat clearance has increased the fragmentation of this subpopulation through the creation of two major gaps around Ravenshoe, the ‘Evelyn Gap’ and the ‘Butchers Creek Gap’. These gaps isolate gliders in the Tumoulin area from those in the Herberton Range to the north and those in the Cardwell Range to the south of Ravenshoe.

(2) The Mt Carbine Tableland subpopulation occurs patchily from the north branch of the Mary River (north of Mt Molloy) north to Smith Creek, a distance of 25 km. There is approximately 10 km of dry sclerophyll forest separating this subpopulation from suitable habitat on the Mt Windsor Tableland, which is believed to be a significant barrier. Gliders in the ‘Little Daintree’ area (see Hedges 2006) are the subject of biannual surveys.

(3) The Mt Windsor Tableland subpopulation is only known to occur around the north-west, west and south-west foothills of the Mt Windsor Tableland, over a distance of 20 km.

The apparent absence of the yellow-bellied glider (Wet Tropics) from suitable habitat in the Lamb Range to the north-east of Atherton and south of the Herbert River on the Seaview Range and Paluma Range is attributed to past climatic regimes (Winter 1997b).

Whether there have been any changes in abundance is uncertain, though glider numbers at Little Daintree are believed to have been fairly constant over the decade they have been monitored (Hedges 2006).

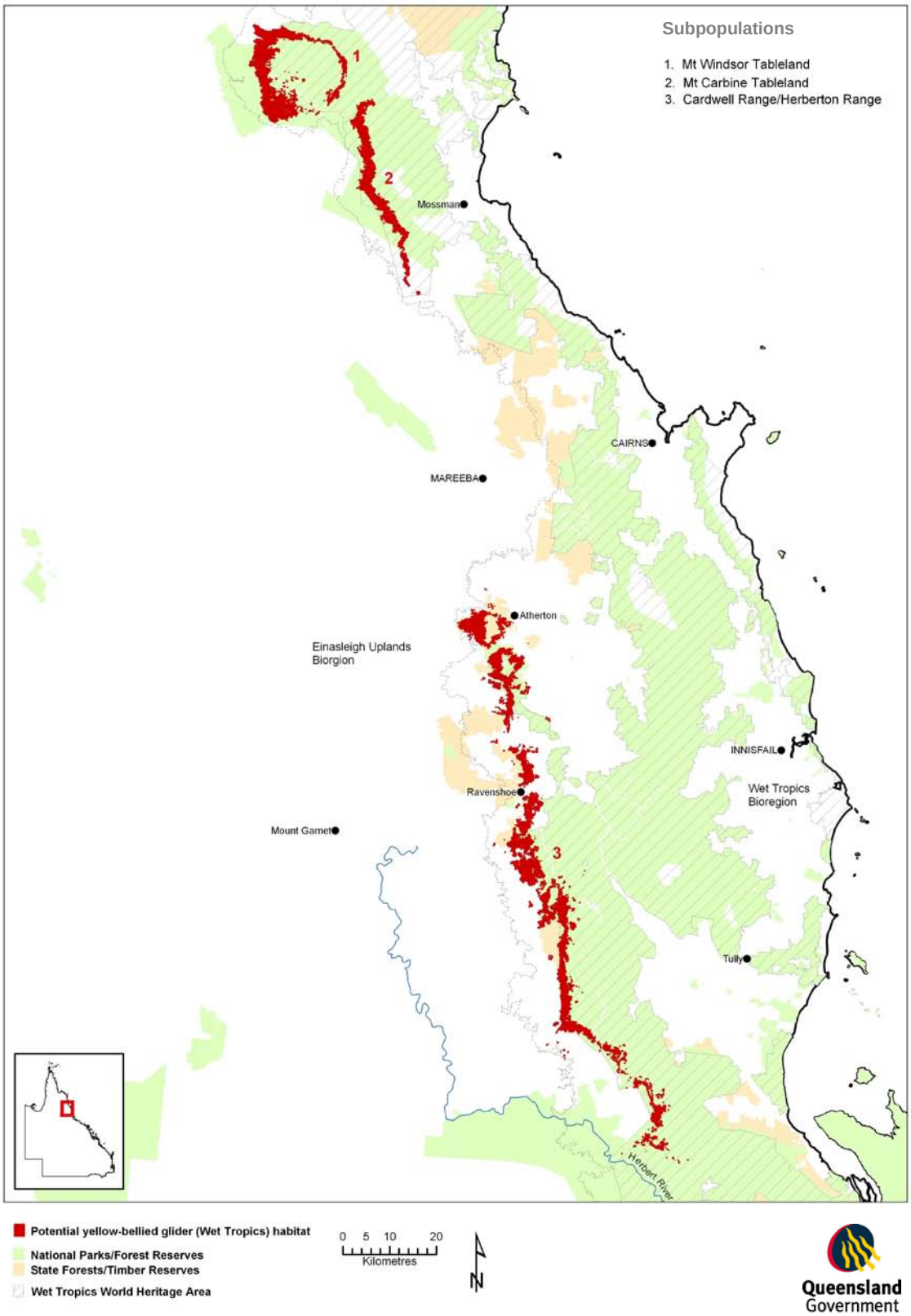

Figure 1: Potential yellow-bellied glider (Wet Tropics) habitat distribution (source: DERM 2007)

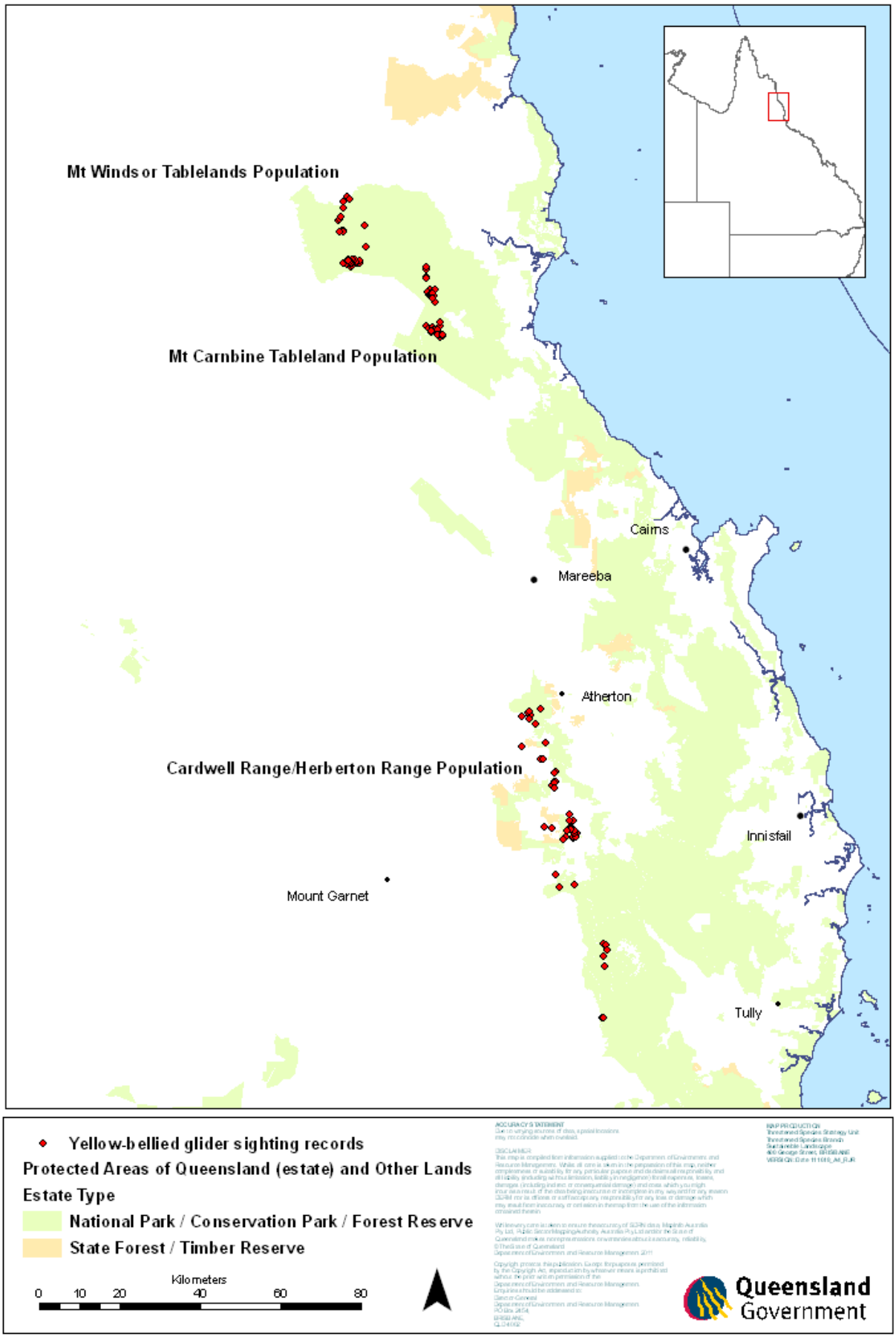

Figure 2: Yellow-bellied glider (Wet Tropics) known distribution (source: DERM 2011)

Habitat critical to the survival of the species

The yellow-bellied glider (Wet Tropics) has been recorded in 11 vegetation types (Table 3). These vegetation types comprise all of or parts of five regional ecosystems that are mapped by DERM (EPA 2007). These vegetation types are the basis for the preliminary mapping of yellow-bellied glider (Wet Tropics) undertaken by DERM (Figure 1).

Table 3: Vegetation communities in which yellow-bellied gliders (Wet Tropics) have been recorded.

Regional ecosystem	Status		Vegetation community	
	VMA[1]	REDD[2]		
7.12.21	Least concern	Endangered	**7.12.21a:**	*Eucalyptus grandis* tall open-forest and woodland. Granites and rhyolites.
			7.12.21b:	*Eucalyptus grandis* tall open-forest and woodland with a well developed vine forest understorey. Granites and rhyolites.
7.12.22	Least concern	Endangered	**7.12.22a:**	*Eucalyptus resinifera*, *Eucalyptus acmenoides*, *Corymbia intermedia*, *Eucalyptus cloeziana*, *Syncarpia glomulifera* tall open-forest to tall woodland with *Allocasuarina torulosa* and *Callitris macleayana*. Uplands and highlands of the moist rainfall zone.
			7.12.22b:	*Eucalyptus resinifera*, *Eucalyptus acmenoides*, *Corymbia intermedia*, *Eucalyptus cloeziana*, *Syncarpia glomulifera* tall open-forest to tall woodland with *Allocasuarina torulosa* and *Callitris macleayana*, and with a very well developed vine forest understorey. Uplands and highlands of the moist rainfall zone.
			7.12.22d:	*Syncarpia glomulifera*, *Eucalyptus resinifera*, and *Corymbia intermedia* open-forest to tall open-forest, often with *Callitris macleayana*, and *Allocasuarina torulosa*. Uplands of the wet rainfall zone.
			7.12.22e:	*Syncarpia glomulifera*, *Eucalyptus resinifera*, and *Corymbia intermedia* open-forest to tall open-forest, often with *Callitris macleayana*, and *Allocasuarina torulosa*, and with a very well developed vine forest understorey. Uplands of the wet rainfall zone.
7.12.27	Least concern	Not of concern	**7.12.27b:**	*Eucalyptus tindaliae* and *Syncarpia glomulifera* medium to tall open-forest and woodland. Uplands and highlands on shallow granitic and rhyolitic soils, of the moist rainfall zone.
7.8.15	Of concern	Endangered	**7.8.15a:**	*Eucalyptus grandis* open-forest to woodland. Basalt.
			7.8.15b:	*Eucalyptus grandis* open-forest to woodland, with a well developed vine forest understorey. Basalt.
7.8.16	Of concern	Endangered	**7.8.16a:**	*Eucalyptus resinifera*, *Corymbia intermedia*, *E. cloeziana*, *Syncarpia glomulifera* open forest and woodland with *Allocasuarina torulosa*. Uplands and highlands on basalt, of the moist rainfall zone.
			7.8.16b:	*Eucalyptus resinifera*, *Corymbia intermedia*, *E. cloeziana*, *Syncarpia glomulifera* open forest and woodland with *Allocasuarina torulosa* and a very well developed vine forest understorey. Uplands and highlands on basalt, of the moist rainfall zone.

1. Queensland *Vegetation Management Act 1999*
2. Regional Ecosystems Description Database version 5.0, Environmental Protection Agency 2005 (Biodiversity status)

Regional ecosystems are mapped by the Queensland Herbarium (Queensland Herbarium and Wet Tropics Management Authority 2005), and are periodically updated (e.g. following work by Stanton & Stanton 2005 in the Wet Tropics). Other projects have mapped eucalypt forest in the Wet Tropics (e.g. Harrington et al. 2005, Williams 2006) and will assist in further defining and mapping yellow-bellied glider (Wet Tropics) habitat.

The two key regional ecosystems (7.12.21 and 7.12.22) comprise 82% of the mapped extent of potential habitat. They are essential habitat when found in connection with each other. The principal habitat requirement in RE 7.12.21 relates to *Eucalyptus grandis*, particularly for den access (although *E. grandis* is also important for pollen, insects and honeydew), while the principal use of RE 7.12.22 is associated with sap feed trees *Eucalyptus resinifera*. Regional ecosystems fringing RE 7.12.21 and 7.12.22 also provide habitat resources and will be periodically visited by the glider. The main use of RE 7.12.27, another important ecosystem type, is likely to relate to feeding on the blossom of turpentine, *Syncarpia glomulifera.*

Under the *Vegetation Management Act 1999* RE 7.12.21 and 7.12.22 have a Vegetation Management Class 'Least Concern', as the current extent of both is close to the pre-clearing extent (>90% of pre-clearing remains). However, both regional ecosystems have a Biodiversity Status of 'Endangered' (EPA 2007), as 'Less than 10% remains unaffected by severe degradation (rainforest invasion, timber harvesting and weed invasion)'.

The current mapped area of potential habitat is estimated as 49,440 ha: 2470 ha associated with the Mt Windsor Tableland subpopulation, 7370 ha associated with the Mt Carbine Tableland subpopulation and 39,600 ha associated with the Cardwell Range - Herberton Range subpopulation (Winter 1997a).

Important populations

The yellow-bellied glider (Wet Tropics) is considered to be one population that has been separated from the southern populations of the yellow-bellied glider. Within this population three major subpopulations are identified.

While three subpopulations are identified, little is known about the yellow-bellied glider (Wet Tropics) population structure. No comprehensive data exist to determine:

i) the extent to which these subpopulations might comprise smaller disjunct units
ii) the extent to which fragmentation has isolated subpopulations
iii) the barriers to dispersal and gene flow

Winter (1997a) gives a maximum population estimate of 5530 which includes the following:

- Mt Windsor subpopulation – maximum number of individuals is 350
- Mt Carbine Tableland subpopulation – maximum number of individuals is 1040
- Cardwell Range - Herberton Range subpopulation – maximum number of individuals is 4140

Studies on the southern yellow-bellied glider suggest that 150 family units is the minimum to ensure a population remains viable (Goldingay and Possingham 1995).

3. Threats

Biology and ecology relevant to threats

The yellow-bellied glider (Wet Tropics) is restricted to a narrow band of wet eucalypt open forest that is an ecotone between rainforest and drier woodland ecosystems. Specific habitat requirements critical to survival are den trees (typically veteran rose gums *Eucalyptus grandis*), and sap feed trees (red mahogany *E. resinifera*), and the connectivity of the two.

Identification of threats

Several threats are affecting the survival of the yellow-bellied glider (Wet Tropics). The threats principally relate to habitat alteration. In order of likely significance these are:

- changed vegetation structure due to change in fire regime and other factors (major)
- clearing and fragmentation of habitat (moderate)
- grazing regime (minor)
- barbed wire fencing (minor)
- climate change (unknown)

The identified threats may have one or several of the following consequences:

- habitat loss
- habitat alteration and fragmentation
- limited eucalypt recruitment
- habitat migration
- loss of individuals

Changed vegetation structure due to change in fire regime and other factors (major)

Winter (2004) considered the loss of habitat through rainforest encroachment to be the principal threat to the glider, particularly where rainforest encroachment has reached an irreversible state where it has progressed to a highly modified structure of a denser closed forest with eucalyptus emergents (DERM QPWS 2011).

Likely impacts on the glider from altered vegetation structure due to changed fire regimes and other factors include:

- habitat loss (including dens)
- habitat alteration and fragmentation (especially rainforest encroachment) affecting movement
- canopy disruption affecting movement
- limited eucalypt recruitment affecting food source and potential dens

The transition from a tall open forest to a thicker, denser structure of a closed forest through rainforest encroachment is thought to impede the passage of the yellow-bellied glider (Wet Tropics), largely negating the competitive advantage of gliding (M. Parsons, pers. comm. 2011). Changes in vegetation structure may also impact on food and den availability.

A number of factors are thought to have contributed to rainforest expansion. Forestry and grazing activity has changed forest structure and thereby fire dynamics, and altered climatic factors (elevated moisture regimes). However, these suggestions have not been well explored. Harrington & Sanderson (1994) showed that 50-70% of tall open forest was ‘captured’ by rainforest expansion between the 1940s and 1990s. Harrington et al. (2005) has updated these estimates stating 80% of rose gum *Eucalyptus grandis* dominated forest has been encroached upon. However, given the significant impacts of changes in management practices on these forests by 1940, including a general cessation of traditional burning regimes and significant use for logging and grazing, the condition of forests in the 1940s may not be representative of pre-European forest structure. Bradford & Harrington (1999) studied habitat in the early stages of rainforest encroachment and found such areas were used for sap-feeding, but doubted sap trees would thrive or reproduce if rainforest continues to develop.

Traditional burning is likely to have been reduced and eventually discontinued during the late 1800s and early to mid 1900s. At the same time fires associated with grazing and forestry activity were introduced and came to dominate forest management for most of the 1900s. However, in the last few decades the expansion of human infrastructure within and adjacent to some habitat, and reduced grazing activity, has meant fire suppression has been used in managing this habitat.

A lack of burning in Wet Tropics wet eucalypt open forest is generally regarded as causing widespread habitat alteration, especially the conversion of grassy understoreys to rainforest. Research does not show that fire of any intensity or frequency will necessarily stop rainforest encroachment (e.g. Williams 2000). Typically rainforests will not burn due to moisture, microclimate conditions and a lack of flammable grasses (Bowman 2000). Scorching of rainforest edges may occur with the presence of high biomass grasses or lantana (Low 2010), particularly within the drier southern half of the wet tropics bioregion. Heavily disturbed rainforest is potentially flammable in severe fire weather. The potential for cyclones and severe fire weather events are expected to increase under climate change predictions (Low 2010).

Fires can play an important role in maintaining moist, open woodland for the yellow-bellied glider (Wet Tropics). Longer inter-fire intervals may lead to a transition from an open to a closed structure (DERM QPWS 2011). Planned burning helps to maintain representative examples of this tall open forest vegetation group, especially grassy dominated ground layers, which have a propensity to transition from open grassy eucalypt forest to closed forest with a lack of fire (DERM QPWS 2011).

The loss of den trees has been attributed to high-intensity burning (Eyre 2005, Gibbons et al. 2000) with fire scars developing at the base of rose gums and contributing to tree collapse. However, the significance of den tree loss associated with fire is unknown. Additionally Adkins (2006) has shown that fire can also play a positive role in hollow development.

Fire management in tall open forest requires a carefully considered integrated approach. Early in the year, the surrounding fire-adapted communities should be burnt to create areas of low fuel that help contain higher severity late season fires. Late season conditions are often required to allow tall open forests to dry sufficiently so they can carry fire. The Department of Environment and Resource Management, Queensland Parks and Wildlife Service has developed planned burn guidelines for the Wet Tropics Bioregion of Queensland (DERM QPWS 2011). These guidelines provide direction towards implementing appropriate fire management practises within a changing climate, including for yellow-bellied glider habitat. The guidelines include information on fire parameters for managing tall open forest at an advanced stage of transitioning.

Clearing and fragmentation of habitat (moderate)

In the past, Wet Tropics wet eucalypt open forests were subjected to clearing and disturbance for forestry and agriculture, especially in the Herberton-Ravenshoe area. Few areas are likely to have been unaffected, although Little Daintree and Mt Spurgeon have remained un-logged. There has also been habitat clearing associated with road construction and powerlines. Logging and habitat clearing has largely ceased for commercial purposes. However, there is still some commercial logging activity occurring in the glider's habitat (e.g. Tumoulin State Forest).

Most new clearing is associated with rural residential activity. There is also the potential for individual feeding trees to be lost as a result of poisoning by energy companies while maintaining the powerlines in glider habitat (such as at Mt Baldy and Herberton Range). Habitat clearing is likely to have influenced fire regimes by fragmenting tracts of forest, and in the case of forestry activity, altering forest structure.

Likely impacts on the glider from habitat clearing include:

- habitat loss (including dens)
- loss of individuals
- habitat fragmentation

Most glider habitat (80%) is within the WTWHA. Habitat outside the protected area estate but within the WTWHA is protected from future clearing (although clearing for non-forestry related purposes (e.g. for grazing) may be allowed on freehold land only if it is not remnant vegetation nor high value regrowth as defined under the *Vegetation Management Act 1999*) and forestry activities. Habitat on protected area estate (e.g. national parks) found inside and outside the WTWHA has even greater legislative protection. However habitat and former habitat (now cleared) that is on private land and in state forest outside the WTWHA (e.g. Mt Baldy near Atherton) are less protected although remnant vegetation and high value regrowth vegetation as defined under the *Vegetation Management Act 1999* cannot be cleared or recleared. While logging prescriptions (via the Code of Practice for Native Forest Timber Production on state lands (Environmental Protection Agency 2007) and associated harvesting plan mechanisms) afford a measure of protection to the yellow-bellied glider (Wet Tropics), there remains some risk of habitat disturbance associated with timber harvesting (Winter 2000).

Grazing regime (minor)
Wet Tropics wet eucalypt open forests with a grassy understorey have a long history of use for cattle grazing. With the introduction of the WTWHA and a reduction in the number of grazing leases on state land (e.g. Mt Windsor Tableland State Forest grazing lease not renewed), cattle grazing has been much reduced. However, it continues to occur in habitat on freehold land and inadequate fencing and the presence of feral cattle results in continued grazing pressure on parts of protected area estate.

Grazing by cattle may have multiple impacts on habitat understorey. Perhaps the greatest impact is through the fire regimes deliberately implemented by graziers to promote 'green pick', especially cool burns at the end of the wet season. Frequent burning to promote green pick eliminates the shrub layer and promotes a simplified understorey comprising of a grassy field layer. Cattle are also likely to influence fire regimes by consuming fine fuels, altering the structure and composition of the understorey through selectively grazing the most palatable vegetation, and disturbing soils perhaps facilitating weed invasion (woody weeds like lantana and non-native grasses). The combined influence of cattle is to reduce the prevalence of fire regimes that facilitate yellow-bellied glider (Wet Tropics) habitat components (i.e. prevent their regeneration). The likely impact on the glider from cattle grazing is habitat alteration (especially rainforest encroachment).

Barbed wire fencing (minor)
Barbed wire fences are generally associated with cattle grazing operations, constructed by either the grazier to contain cattle, or by adjacent landholders to restrict cattle from entering their land. Entanglement in barbed wire is a threat to wildlife generally (Booth 2007) and has caused the death of yellow-bellied gliders (Wet Tropics). It is presumed that the yellow-bellied glider (Wet Tropics) entangles in barbed wire while gliding. An entangled animal is likely to die from dehydration, starvation or predation. It is possible that animals encountering (but not becoming entangled in) barbed wire receive injuries to their delicate gliding flaps (patagia).

The likely impact on the glider from injury by, or entanglement in, barbed wire fences is loss of individuals.

The extent of mortality caused by entanglement with or injury by barbed wire is unknown. Incidents have been reported and the impact on populations is likely to be localised. However, in the early 1990s seven carcasses were removed over several days from a 2 km stretch of barbed wire running through prime habitat at Mt Carbine Tableland (R. Russell, pers. comm.). Areas where barbed wire fencing occurs through prime habitat, or adjacent to forest gaps that are traversed by the glider (such as roads), may present a higher entanglement risk.

Climate change (unknown)
Anthropogenic activity is contributing to global climate change (Natural Resource Management Ministerial Council 2004) and it is believed that montane or upland areas will be particularly affected. Whilst there is considerable general modelling of climate change, and some specifically considering Wet Tropics habitat (e.g. Hilbert et al. 2001), current modelling may be too simplistic to offer realistic predictions in the topographically complex Wet Tropics.

Climate change is likely to influence the distribution of habitat, through the migration of bioclimates that support habitat, and by influencing fire regimes. The wet eucalypt open forest habitat is a narrow ecotone between rainforest and dry open forest, and the distribution and availability of this niche could 'migrate' or be eliminated. Areas which now support dry sclerophyll forest have soils that are unsuitable for the development of wet sclerophyll forest.

Possible impacts on the glider from climate change include:

- habitat loss (including dens)
- habitat alteration (especially rainforest encroachment and change in phenological patterns)
- habitat fragmentation

Areas and subpopulations under threat

Population and habitat knowledge is not sufficient to identify specific areas of habitat or subpopulations under highest threat. However, areas and/or subpopulations under threat generally may include:

- areas where habitat has a low number of potential den trees or den tree recruits;
- habitat on private land;
- areas with the fastest rates of rainforest encroachment;
- areas with poor connectivity to current and predicted habitat; and
- areas with fragmented habitats and associated population effects.

Areas with low numbers of potential den trees and habitat on private land may be under the most imminent risk. Sub-populations that are small and localised have a lower chance of remaining viable over the long-term. These populations are also likely to be more impacted by stochastic events.

4. Recovery objectives, performance criteria and actions

Overall objective

To manage the impact of threatening processes on yellow-bellied gliders (Wet Tropics) to protect and recover populations throughout their range.

Objective 1 – Determine essential habitat

Action 1.1 – Define essential habitat distribution

Rationale – Regional ecosystem mapping undertaken by the Queensland Herbarium (Queensland Herbarium 2005) forms the legal basis of vegetation protection in Queensland. The Wet Tropics regional ecosystem mapping (Queensland Herbarium and Wet Tropics Management Authority 2005) is a subset of this, and is derived from the work of Stanton and Stanton (2005). Harrington et al. (2005) have also spatially defined vegetation of the western Wet Tropics, concentrating on the wet sclerophyll forests.

Existing mapping resources and locality records of the yellow-bellied glider (Wet Tropics) will provide the basis for creating a spatial definition of essential habitat (under the *Vegetation Management Act 1999*). This layer together with other statutory planning mechanisms will inform land use planning and habitat protection initiatives. It will also

provide a basis for on-ground species management decisions and research methodology. A preliminary potential habitat map has been developed by DERM as the first step in this process (Figure 1). Maps will be assessed to identify essential habitat and used to guide management of the yellow-bellied glider.

Performance criterion 1.1.1 – Essential habitat map produced and made available to all relevant stakeholders.
Potential contributors – DERM, WTMA, Cook Shire Council and Cairns, Tablelands and Cassowary Coast regional councils.

Objective 2 – Implement fire regimes to maintain essential habitat and control rainforest expansion on protected area estate

Action 2.1 – Implement adaptive fire management for yellow-bellied glider (Wet Tropics)

Rationale – The majority of habitat (over 80%) is in protected area estate. The future of the yellow-bellied glider (Wet Tropics) is intimately linked to the persistence of wet eucalypt open forest. The encroachment of rainforest may limit eucalypt regeneration. While encroached habitat may currently provide den and feed trees, the lack of regeneration may affect long-term availability.

Documentation of rainforest encroachment and factors influencing the process is vital to guiding successful habitat management. It is widely considered that reduced fire frequency/intensity may have facilitated the encroachment, but forest use for grazing and forestry, and fire breaks in the form of roads and power easements are also likely to have had some influence.

Analysis of existing vegetation mapping (e.g. Harrington et al. 2005, Queensland Herbarium and Wet Tropics Management Authority 2005, Stanton and Stanton 2005), land use history, climatic data and geomorphology will allow a better understanding of rainforest encroachment. Habitat must be sustainable in distribution and succession and a more targeted and/or extensive use of fire may be essential.

The initiation and ongoing use of habitat monitoring in response to fire, using an adaptive management approach will allow knowledge to be gained and refined, while allowing immediate on-ground actions. Monitoring habitat response to various fire management strategies over a lengthy period is the only reliable way to increase ecological understanding of fire and rainforest encroachment. Monitoring could occur at the sub-catchment level (10 - 40 ha) using aerial photos and/or long transects (c. 500 m in length). The DERM QPWS Planned Burn Guidelines for the Wet Tropics Bioregion, Queensland should be used to help inform burning practices.

Performance criterion 2.1.1 – Analysis of rainforest encroachment dynamics documented and made available to relevant stakeholders (e.g. report submitted on DERM's Recovery Actions Database).
Performance criterion 2.1.2 – Habitat response to fire management assessed and monitored.
Potential contributors – DERM, CSIRO, research organisations such as JCU, Marine and Tropical Sciences Research Facility (MTSRF), and Reef and Rainforest Research Centre Limited (RRRC), WTMA, DSEWPaC, ARC, GAC, TKMG private landholders, Cook Shire Council, Cairns, Tablelands and Cassowary Coast regional councils, field naturalists, private sanctuary managers such as AWC.

Objective 3 – Protect and manage habitat outside protected area estate

Action 3.1 – Facilitate the protection and management of habitat outside protected area estate

Rationale – While most existing habitat is in protected area estate, some habitat and former habitat (now cleared) is under other jurisdictions – predominantly state land (tenures including state leasehold and state forest) and some freehold (approximately 2000 ha of mapped glider habitat).

State owned forest covers approximately 20% of the glider's known habitat. Some of this forested area may still be subject to timber logging. Timber logging in these forests needs to be managed to prevent disturbance to critical glider habitat. This could include a reassessment of the Code of Practice for Native Forest Timber Production to ensure that it identifies practices that prevent the disturbance of glider habitat. An example may include, re-assessing the buffer zones for logging around food and nesting trees.

Land used for powerlines can be managed through permits issued under the *Nature Conservation Act 1992* to ensure the conservation of glider habitat, including the identification and protection of feed and den trees.

Performance criterion 3.1.1 – An extension program to encourage and support landholders/land managers to better manage glider habitat implemented.
Potential contributors DERM, Terrain NRM, community conservation groups, Cook Shire Council, Cairns, Tablelands and Cassowary Coast regional councils, private landholders, private sanctuary managers such as AWC, Bush Heritage Australia volunteers.

Action 3.2 – Regenerate habitat corridors between existing glider habitat

Rationale – Habitat connectivity is a vital requirement for improving conservation prospects by minimising inbreeding and allowing supplementation and recolonisation of subpopulations. Yellow-bellied glider (Wet Tropics) habitat is somewhat discontinuous throughout its range, with some of this caused or exacerbated by past clearing of vegetation.

The habitat discontinuity could be addressed through creating effective habitat corridors in areas where fragmentation has been due to clearing. The use of glider poles and / or artificial hollows may be incorporated into the habitat to increase continuity. Areas need to be identified and prioritised for on ground rehabilitation work. The use of maps and genetic data (Action 5.2) may assist in understanding glider movement patterns in fragmented landscapes.

Performance criterion 3.2.1 – Areas where habitat corridors may be created are identified.
Performance criterion 3.2.2 – Habitat regeneration initiated.
Potential contributors – community conservation groups, Terrain NRM, DERM, WTMA, Cook Shire Council, Cairns, Tablelands and Cassowary Coast regional councils, private landholders, Trees for the Evelyn and Atherton Tableland (TREAT) and Tree Kangaroo and Mammal Group (TKMG).

Objective 4 – Research the impacts of cattle and barbed wire on gliders and glider habitat

Action 4.1 – Conduct research into the impacts of cattle on glider habitat

Rationale – The grassy understorey of the Wet Tropics wet eucalypt open forests have a long history of cattle grazing. There has been a reduction in the number of grazing leases on state land, however cattle continue to occur in some glider habitat and their full impact on gliders is unknown.

Historically cattle graziers use fire to promote 'green pick', especially cool burns at the end of the wet season. These frequent fires can eliminate the shrub layer and promote a simplified understorey comprising of a grassy field layer. Cattle may also disturb soil through erosion, facilitate weed invasion and alter the essential habitat for the yellow-bellied glider.

A thorough understanding of the impacts of cattle on glider habitat is required to ensure an appropriate management strategy is implemented. Communication with landholders associated with operations will be necessary to gain understanding and cooperation for cattle management actions. Consideration of the interests of Indigenous people will be important.

Performance criterion 4.1.1 – Research into the impacts of cattle on glider habitat is undertaken.
Potential contributors – WTMA, DERM, research institutions, Terrain NRM, DEEDI, private landholders, private sanctuary managers such as AWC.

Action 4.2 – Collate existing data on yellow-bellied glider (Wet Tropics) barbed wire incidents and establish a reporting process through WildNet.
Rationale – No mechanism currently exists for centralised data capture on yellow-bellied glider (Wet Tropics) and barbed wire incidents. Establishing a process in which wildlife carer groups can report barbed wired incidents through WildNet will be important in understanding the impact barbed wire might have on the species. Where possible, historical data will be collated from the wildlife carer groups in order to implement Action 4.3.

Performance criterion 4.2.1 Reporting mechanism established and used by wildlife carer groups to report yellow-bellied glider (Wet Tropics) barbed wire incidents.
Potential contributors – DERM, Research institutions, local wildlife carer groups, RSPCA, Terrain NRM.

Action 4.3 – Analyse yellow-bellied glider (Wet Tropics) barbed wire incident data to establish level of impact and identify potential hotspot locations for management.
Rationale – Little is known about the level of impact bared wire entanglements have on yellow-bellied glider (Wet Tropics) populations. By analysing the information collected under Action 4.2 we will gain a better understanding of the impacts of barbed wire and the identification of potential hotspot locations for targeted management (Action 4.4).

Performance criterion 4.3.1 - Level of impact of barbed wire on yellow-bellied glider (Wet Tropics) populations is determined and potential hotspot locations are identified for management.
Potential contributors – DERM local wildlife carer groups, RSPCA, Terrain NRM, WTMA, research institutions

Action 4.4 – Implement an extension program for landholders on appropriate grazing regimes and fencing modification in glider habitat
Rationale – An education program to provide information on the impacts that grazing can have on glider habitat and the impact of barbed wire on gliders to be implemented. Encourage graziers to implement appropriate grazing regimes, as well as minimise the use of barbed wire in known glider habitat, so as to reduce the impacts on the yellow-bellied glider and its habitat.

Performance criterion 4.4.1 – An extension program for graziers implemented.
Performance criterion 4.4.2 – Barbed wire removed from fences in locations where gliders are found to be affected.

Potential contributors – WTMA, DERM, Terrain NRM, DEEDI, Cook Shire Council, Cairns, Tablelands and Cassowary Coast regional councils, private landholders, community conservation groups, private sanctuary managers such as AWC.

Objective 5 – Assess and monitor glider populations

Action 5.1 – Undertake a monitoring program to assess the number of gliders in known habitat

Rationale – To date little is known about the yellow-bellied glider (Wet Tropics) population structure. Data is required to determine subpopulations that comprise smaller disjunct units; isolated population numbers due to habitat fragmentation; and barriers to gene flow.

Performance criterion 5.1 – Glider monitoring programs implemented to assess population numbers.
Potential contributors – DERM, Terrain NRM, CSIRO, research institutes such as JCU, MTSRF and RRRC.

Action 5.2 – Conduct genetic analysis of the yellow-bellied glider (Wet Tropics) population

Rationale – Very little genetic work has been done on the yellow-bellied glider (Wet Tropics). While three subpopulations of the yellow-bellied glider (Wet Tropics) are identified, little is known about the glider's population structure. No comprehensive data exist to determine:

i) the extent to which these subpopulations might comprise smaller disjunct units
ii) the extent to which fragmentation has isolated subpopulations
iii) the barriers to dispersal and gene flow

Knowledge of genetic structure of the population can provide important insights into the population to allow appropriate management (Action 5.1).

Performance criterion 5.2 – Genetic structure of the yellow-bellied glider (Wet Tropics) population assessed with recommended management implications provided to relevant stakeholders.
Potential contributors – DERM, Terrain NRM, CSIRO, research institutes such as JCU, MTSRF and RRRC.

Objective 6 – Improve understanding of climate change impacts

Action 6.1 – Investigate impacts of climate change on glider habitat

Rationale – Narrow ecotonal habitats such as Wet Tropics wet eucalypt open forest are likely to experience a significant distribution shift with climate change due to altered bioclimatic regimes. Predicting land conducive to supporting wet eucalypt open forest under new climatic regimes is important in planning for habitat persistence. Facilitating identification and support for landscape corridors and habitat 'stepping stones' to significant/long-term refugia will improve likelihood of survival. Understanding current land use and ownership is important to developing strategies to facilitate the migration of this habitat. Landscape corridors facilitate the natural movement of species and ecosystems, and add ecological and evolutionary resilience to landscapes. The capacity and approach to achieving landscape corridors is dependent upon the ability to influence land management. Existing Wet Tropics climate change models could be calibrated to focus on the requirements of wet eucalypt open forest.

Performance criterion 6.1.1 – Impacts of climate change on glider habitat investigated.
Potential contributors – CSIRO, research organisations such as JCU, MTSRF and RRRC, WTMA, DERM.

Actions summary table - P[a] = Priority ranking 1 = High priority, 2 = Medium priority, 3 = Low priority.

Objective	Action	Performance Criteria	Potential contributors	P[a]
1. Determine essential habitat	**1.1** Define essential habitat distribution.	**1.1.1** Essential habitat map produced and made available to all relevant stakeholders.	DERM, WTMA, Cook Shire Council and Cairns, Tablelands and Cassowary Coast regional councils.	1
2. Implement fire regimes to maintain essential habitat and control rainforest expansion on protected area estate	**2.1** Implement adaptive fire management for yellow-bellied glider (Wet Tropics).	**2.1.1** Analysis of rainforest encroachment dynamics documented and made available to relevant stakeholders (e.g. report submitted on DERM's Recovery Actions Database).	DERM, CSIRO, research organisations such as JCU, MTSRF and RRRC, WTMA, ARC, DSEWPaC, GAC, private landholders, Cook Shire Council, Cairns, Tablelands and Cassowary Coast regional councils, field naturalists, private sanctuary managers such as AWC, volunteers.	1
		2.1.2 Habitat response to fire management assessed and monitored.		
3. Protect and manage habitat outside protected area estate	**3.1** Facilitate the protection and management of habitat outside protected area estate.	**3.1.1** An extension program to encourage and support landholders/land managers to better manage glider habitat implemented.	DERM, Terrain NRM, community conservation groups, Tablelands Regional Council, private landholders, private sanctuary managers such as AWC, BHA volunteers.	2
	3.2 Regenerate habitat corridors between existing glider habitat.	**3.2.1** Areas where habitat corridors may be created are identified.	Community conservation groups, Terrain NRM, DERM, WTMA, Cook Shire Council, Cairns, Tablelands and Cassowary Coast regional councils, private landholders, TREAT, and TKMG.	2
		3.2.2 Habitat regeneration initiated.		
4. Research the impact of cattle and barbed wire on gliders and glider habitat	**4.1** Conduct research into the impacts of cattle on glider habitat.	**4.1.1** Research into the impacts of cattle on glider habitat is undertaken.	WTMA, DERM, research institutions, Terrain NRM, private landholders, private sanctuary managers such as AWC, DEEDI.	3
	4.2 Collate existing data on yellow-bellied glider (Wet Tropics) barbed wire incidents and establish a reporting process through WildNet.	**4.2.1** Reporting mechanism established and used by wildlife carer groups to report yellow-bellied glider (Wet Tropics) barbed wire incidents.	DERM WildNet, local wildlife carer groups, RSPCA, Terrain NRM.	

	4.3 Analyse yellow-bellied glider (Wet Tropics) barbed wire incident data to establish level of impact and identify potential hotspot locations for management.	**4.3.1** Level of impact of barbed wire on yellow-bellied glider (Wet Tropics) populations is determined and potential hotspot locations are identified for management.	DERM, local wildlife carer groups, RSPCA, Terrain NRM, WTMA, research institutions	
	4.4 Implement an extension program for landholders on appropriate grazing regimes and fencing modification in glider habitat.	**4.4.1** An extension program for graziers implemented.	WTMA, DERM, Terrain NRM, Cook Shire Council, Cairns, Tablelands and Cassowary Coast regional councils, community conservation groups, DEEDI, private landholders, private sanctuary managers such as AWC.	2
		4.4.2 Barbed wire removed from fences in locations where gliders are found to be affected.		
5. Assess and monitor glider populations	**5.1** Undertake a monitoring program to assess the number of gliders in known habitat	**5.1.1** Glider monitoring programs implemented to assess population numbers.	DERM, Terrain NRM, CSIRO, research institutes such as JCU, MTSRF and RRRC.	1
	5.2 Conduct genetic analysis of yellow-bellied (Wet Tropics) population	**5.2.1** Genetic structure of the yellow-bellied glider (Wet Tropics) population assessed with recommended management implications provided to relevant stakeholders.		2
6. Improve understanding of climate change impacts	**6.1** Investigate impacts of climate change on glider habitat.	**6.1.1** Impacts of climate change on glider habitat investigated.	CSIRO, research organisations such as JCU, MTSRF and RRRC, WTMA, DERM.	3

5. Management practices

Most habitat of the yellow-bellied glider (Wet Tropics) is within the protected area estate managed by DERM. Management includes the implementation of appropriate fire regimes, minimising the impact of cattle and enhancing wildlife corridors. The provisions of the *Vegetation Management Act 1999* are the main tools for limiting habitat clearing/modification of eucalypt forest on private land. Any harvesting of native forest on freehold properties is regulated under a code enforced by the *Vegetation Management Act 1999* and the *Sustainable Planning Act 2009*.

A range of other Wet Tropics planning mechanisms provide conservation and habitat management guidance, and include:

- the Wet Tropics Terrain Regional Plan
- Wet Tropics NRM Plans
- Local Government planning schemes
- the Wet Tropics Conservation Strategy

Several further State and Local Government planning mechanisms (e.g. Local Government planning schemes and nature refuge agreements under the Queensland *Nature Conservation Act 1992*) have a statutory basis.

The Commonwealth EPBC Act deals with matters of national environmental significance (e.g. World Heritage, threatened species) on public and private land. Proponents of development applications need to demonstrate that significant impacts as defined under the EPBC Act are unlikely to occur.

Management guidelines to prevent significant adverse impacts on the yellow-bellied glider (Wet Tropics) habitat include the following:

- Retain all veteran rose gums as potential den trees.
- Retain all feed trees and ensuring their connectivity to den trees.
- Protect important habitat outside protected area estate.
- Prevent rainforest encroachment on wet eucalypt open forest.
- Implement fire regimes that support old growth refuge and mixed age forests.
- Plan and implement landscape corridors and ‘stepping stones’ to facilitate wet eucalypt open forest migration under climate change.
- Prevent further habitat fragmentation and the widening of existing habitat breaks.
- Remove cattle from protected area estate.
- Implement appropriate grazing regimes on private and leasehold land.
- Monitor yellow-bellied glider (Wet Tropics) habitat and subpopulations.

6. Estimated costs

Objective	Action if implemented	Year1($)	Year2($)	Year3($)	Year4($)	Year5($)	Total($)
1. Determine essential habitat	**1.1** Define essential habitat distribution.	20,000	1,000	1,000	1,000	1,000	24,000
2. Implement fire regimes to maintain essential habitat and control rainforest expansion on protected area estate	**2.1** Implement adaptive fire management for yellow-bellied glider (Wet Tropics).	20,000	20,000	20,000	20,000	20,000	100,000
3. Protect and manage habitat outside protected area estate	**3.1** Facilitate the protection and management of habitat outside protected area estate.	5,000	5,000	5,000	5,000	5,000	25,000
	3.2 Regenerate habitat corridors between existing glider habitat.	0	0	20,000	20,000	20,000	60,000
4. Research the impact of cattle and barbed wire on gliders and glider habitat	**4.1** Conduct research into the impacts of cattle on glider habitat.	5,000	5,000	5,000	5,000	5,000	25,000
	4.2 Collate existing data on yellow-bellied glider (Wet Tropics) barbed wire incidents and establish a reporting process through WildNet.	5,000	2,000	0	0	0	7,000
	4.3 Analyse yellow-bellied glider (Wet Tropics) barbed wire incident data to establish level of impact and identify potential hotspot locations for management.	0	2,000	0	2,000	0	4,000
	4.4 Implement an extension program for landholders on appropriate grazing regimes and fencing modification in glider habitat.	2,000	2,000	2,000	2,000	2,000	10,000
5. Assess and monitor glider population	**5.1** Undertake a monitoring program to assess the number of gliders in known habitat.	10,000	10,000	10,000	5,000	5,000	40,000
	5.2 Conduct genetic analysis of yellow-bellied (Wet Tropics) population.	10,000	10,000	0	0	0	20,000
6. Improve understanding of climate change impacts	**6.1** Investigate impacts of climate change on glider habitat.	0	0	0	5,000	5,000	10,000
	Estimated total cost per year ($)	**77,000**	**57,000**	**63,000**	**65,000**	**63,000**	**325,000**

7. Evaluation of recovery plan

An annual assessment will be conducted to assess progress towards recovery. This will include an evaluation of the overall progress as well as progress made on individual actions. A review of the recovery plan will be undertaken five years from its adoption and in accordance with the Australian Government Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC guidelines). Completion of actions within this plan may require reporting by contributors to DSEWPaC. Reporting will also be available through DERM's Recovery Action Database (an interactive web-based information system) which is currently in development.

Acknowledgments

This recovery plan was prepared by Lee Halasz of the former EPA, Lara Connell and Sarah Parker-Webb of DERM. Significant contribution by Peter Latch and John Winter of the former EPA is greatly appreciated. Thanks also go to all those who provided valuable comments on the plan.

List of Abbreviations

ARC	Aboriginal Rainforest Council
AWC	Australian Wildlife Conservancy
BHA	Bush Heritage Australia
CSIRO	The Commonwealth Scientific and Industrial Research Organisation
DEEDI	Queensland Department of Employment, Economic Development and Innovation
DERM	Queensland Department of Environment and Resource Management
DSEWPaC	Australian Government Department of Sustainability, Environment, Water, Population and Communities
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
GAC	Girringun Aboriginal Corporation
JCU	James Cook University
MTSRF	Marine and Tropical Sciences Research Facility
NCA	Queensland *Nature Conservation Act 1992*
RRRC	Reef and Rainforest Research Centre Limited
Terrain NRM	Terrain Natural Resource Management
TKMG	Tree Kangaroo and Mammal Group
TREAT	Trees for the Evelyn and Atherton Tableland
WPSQ	Wildlife Preservation Society of Queensland
VMA	Queensland *Vegetation Management Act 1999*
WTMA	Wet Tropics Management Authority
WTWHA	Wet Tropics World Heritage Area

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