Recovery plan for the southern cassowary
Casuarius casuarius johnsonii

Prepared by Peter Latch for the Cassowary Recovery Team

Australian Government

Queensland Government
Environmental Protection Agency

Title: Recovery plan for the southern cassowary *Casuarius casuarius johnsonii*

Prepared by: Peter Latch for the Cassowary Recovery Team

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Executive Summary

Species
The southern cassowary *Casuarius casuarius johnsonii* is a large flightless bird found in north Queensland rainforests and associated vegetation mosaics.

Current species status
The southern cassowary is listed as 'Endangered' under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. Under the Queensland *Nature Conservation Act 1992,* the Wet Tropics population is listed as 'Endangered' and the Cape York populations are listed as 'Vulnerable'.

Habitat and distribution summary
Although occurring primarily in rainforest and associated vegetation, the cassowary also uses woodland, swamp and disturbed habitats for a year-round supply of fleshy fruits. It occurs in three broad populations. In the Wet Tropics it is distributed widely from Cooktown to just north of Townsville. Core habitat is coastal lowlands between Ingham and Mossman, and uplands in the southern Atherton Tablelands and other ranges. On Cape York, it occurs as two disjunct populations in vine-forest communities: one in MacIlwraith and Iron Ranges, the other in Shelburne Bay.

Threats summary
The Wet Tropics cassowary population is impacted upon by eight main threats. These same threats are absent or of lesser significance for the Cape York population.

1. Habitat loss from clearing: more than 80 per cent of coastal lowland habitat has gone.
2. Habitat fragmentation: much of remaining habitat is fragmented, isolating groups and disrupting movement.
3. Habitat degradation: through invasion of weeds such as pond apple, and changed fire regimes.
4. Roads and traffic: cassowaries are killed by vehicles on roads.
5. Dog attacks: urban development brings more domestic dogs.
6. Hand feeding: brings cassowaries closer to vehicle traffic and dogs.
7. Diseases: aspergillosis, avian tuberculosis and parasites.
8. Natural catastrophic events: cyclones.

Overall recovery objective
The overall objective of this recovery plan is to protect cassowaries, habitats and corridors from threats through better planning, monitoring and community involvement.

Summary of recovery actions
The following recovery actions are required:

- complete the mapping of essential cassowary habitat and identify areas and corridors to protect, restore and manage
- develop and implement Cassowary Conservation Local Area Plans as part of local planning
- minimise cassowary road deaths and dog attacks, and assess impact of pigs
- implement a translocation plan as part of rescue, rehabilitation and release
- establish a monitoring programme in key habitats
- develop and implement a population survey methodology based on faecal DNA
- study cassowary population at Mission Beach and determine genetic structure *and*
- involve community in cassowary conservation.

Evaluation and review
Members of the recovery team will review and evaluate progress annually. An independent external examiner will review and evaluate performance of the recovery plan within five years of the plan being adopted.

1. General information

Conservation status

The southern cassowary *Casuarius casuarius johnsonii* is listed as 'Endangered' under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and under the Queensland *Nature Conservation Act 1992* (NC Act) the Wet Tropics population is listed as 'Endangered' and the Cape York populations are listed as 'Vulnerable'.

International obligations

The southern cassowary is not listed under any international agreements. This recovery plan is consistent with Australia's international responsibilities.

Affected interests

Given their extensive distribution throughout the Wet Tropics and Cape York, cassowaries occur on many land tenures. Cassowaries are of great conservation interest to the general community, are of significant cultural importance to Aboriginal communities and of scientific interest to researchers. Affected government authorities, organisations and individuals include:

- Environmental Protection Agency (EPA)
- Wet Tropics Management Authority
- Queensland Department of Natural Resources and Water
- Queensland Department of Primary Industries and Fisheries
- Queensland Department of Main Roads
- Local governments of Atherton, Cairns, Cardwell, Cook, Douglas, Dalrymple, Eacham, Herberton, Hinchinbrook, Johnstone, Mareeba and Thuringowa
- Regional Natural Resource Management Bodies (NRM) – Terrain Queensland NRM (Far North Queensland), Cape York Community Engagement Group
- Aboriginal communities, councils and representative bodies – Aboriginal Rainforest Council and Girringun Aboriginal Corporation
- Land and Sea Management Centres on Cape York
- Local community conservation groups
- Conservation groups including the Cairns and Far North Environment Centre, Birds Australia and Wildlife Preservation Society of Queensland
- Scientific research organisations including CSIRO and universities
- Private landholders
- Tourism bodies and local operators *and*
- Zoological institutions and associated industry organisations e.g. the Australasian Regional Association of Zoological Parks and Aquaria (ARAZPA)

Consultation with Indigenous people

In the implementation of recovery actions, consideration will be given to the interests of Indigenous people whose land the cassowary is found on, and involvement from these groups encouraged. The plan allows for traditional owners to be represented through Aboriginal corporations, Land and Sea Management Centres and communities. The Aboriginal Rainforest Council represents 17 Traditional Owner groups in the Wet Tropics and the Girringun Aboriginal Corporation represents Traditional Owners at a sub-regional level in the southern part of the Wet Tropics Region. Both helped develop the plan and are part of the recovery team.

Benefits to other species or communities

The cassowary is a major disperser of rainforest plant seeds and the only long distance disperser of some species with large fleshy fruits. Because it is essential to forest ecology and habitats of diverse species, the cassowary is a "keystone" species (i.e. one whose conservation is crucial to other species and ecosystems).

In the Wet Tropics, 800,000ha of essential cassowary habitat includes 91 Regional Ecosystems of which 15 are 'Endangered' and 23 'Of concern' under the *Vegetation Management Act 1999* (VM Act) (Appendix 2). Its habitat includes more than 106 plant species and 37 animal species

identified as threatened under State and Commonwealth legislation. Protection of cassowary habitat will secure the habitat of many other species and ecological communities.

Social and economic impacts

The implementation of this recovery plan is unlikely to cause significant adverse social and economic impacts. Issues surrounding protection and retention of habitat and any likely impact on landholders have been considered in the development of the Wet Tropics Regional Vegetation Management Codes for Broadscale Clearing and for Ongoing Clearing Purposes developed under the VM Act. In addition, the use of economic and other incentives for retaining cassowary habitat is subject to various actions within the plan.

Successful recovery efforts may have positive social, economic and educational impacts. The cassowary is a flagship for Wet Tropics rainforest conservation. As this plan intends to raise the profile of the cassowary, it may offer new economic opportunities and benefits to local communities.

2. Biological information

Species description

Cassowaries belong to the ratite group of large flightless land birds. Of the three species, only the southern cassowary, *Casuarius casuarius johnsonii*, is found in Australia. It is the largest native vertebrate in Australian rainforests. Adults grow to two metres tall with males up to 55kg and females, usually larger, up to 76kg (Westcott and Reid 2002, QPWS unpub. data).

Newly hatched chicks are striped dark brown and creamy white. After three to six months the stripes fade and the plumage changes to brown. As the young mature the plumage darkens, the wattles and casque develop and the skin colour on the neck and wattles brighten.

Adults have shiny black plumage and a distinctive neck and head: brilliant blue and purple with long, drooping red wattles and amber eye. The tall helmet or casque on maturing birds grows with age. Each leg has three toes, with the inside toe bearing a large dagger-shaped claw. The sexes are fairly similar though females are slightly larger. Cassowaries mature at about three years of age.

Life history and ecology

Although occurring primarily in rainforest and associated vegetation mosaics, the cassowary also uses woodland, swamp and disturbed habitats as intermittent food sources and as connecting habitat between more suitable sites (Crome and Moore 1993; Bentrupperbäumer 1998). It requires a high diversity of fruiting trees to provide a year-round supply of fleshy fruits. While some habitats may be important only briefly in the annual cycle of food production, they may be crucial to the survival of cassowaries whose home range encompasses them (Bentrupperbäumer 1998). Crome and Moore (1990) suggest that at times of food stress in the rainforest, such as after cyclones, food resources in non-rainforest habitats may be more important.

Their diet includes fleshy fruits of up to 238 plant species, including seven exotics (Westcott et al. 2005). While fallen fruit is the primary food source, cassowaries also eat small vertebrates, invertebrates, fungi, plants and carrion (Marchant and Higgins 1990). They forage for about 35 per cent of the day, mainly early morning and late afternoon (Westcott et al. 2005).

A large majority of seeds ingested by cassowaries retain their viability and are passed whole (Stocker and Irvine 1983, Crome and Moore 1990, Bentrupperbäumer 1992). It has been demonstrated that passage of some seeds through cassowaries can improve germination rates (Webber and Woodrow 2004).

Cassowaries are one of only a few frugivores that can disperse large rainforest fruits and are the only long distance dispersal vector for large seeded fruits (Crome and Moore 1988, 1990; Westcott et al. 2005). It has been estimated that on average cassowaries move four per cent of seeds they

consume more than 1km and an estimated average maximum distance of 1.473km (Westcott at al. 2005). These data indicate that cassowaries have the potential to provide significantly longer dispersal on occasion, as much as 5.41km. The combination of long distance dispersal ability and landscape scale movement means that cassowaries play a significant role in moving seeds between populations and into new regenerating areas (Westcott et al. 2005). The loss of cassowaries from part or all of their range results in relatively rapid changes in fruit dimensions and population level dynamics, particularly for large-seeded species (Westcott et al. 2005).

The cassowary is territorial and solitary, with contact between mature individuals generally only tolerated during mating. Sexes will maintain independent but overlapping home ranges with female home ranges encompassing those of one to several males (Bentruperbäumer 1998). Home ranges fluctuate depending on season and availability of fruit, with estimates of between 0.52km^2 to 2.35km^2 recorded (Bentrupperbäumer 1998; Moore and Moore 2001). Cassowaries may also tolerate each other in areas of super abundant fallen fruit and have been known to congregate in areas when artificially fed on a regular basis (QPWS unpublished).

Females lay three to five olive-green eggs, generally between June and October. Males incubate the clutch for about 50 days before raising the young alone for about a year (Bentrupperbäumer 1998). Young birds must then seek their own home range, but with limited opportunities, particularly due to high fragmentation and loss of habitat, the sub-adult mortality rate is probably high.

Distribution, abundance and population trends

Cassowaries in the Wet Tropics were historically distributed between Cooktown in the north, south to Townsville and west to the extent of rainforest including the entire rainforested portion of the Atherton Tableland (Marchant and Higgins 1990). Present distribution remains similar but greatly reduced and fragmented by forest clearance. Areas in which cassowaries are thought to be extinct include large parts of the Atherton Tablelands, the lower Goldsborough Valley, the floor of the Whyanbeel valley, the Clohesy River region and the Cassowary Range (Crome and Moore 1990). The species has seldom been reported from around Cooktown, and near Townsville it only occurs in low abundances in higher altitude areas of Bluewater and Mt Spec. Core habitat remains in the rainforest and associated habitats of the coastal lowlands between Ingham and Mossman, and the upland areas incorporating Seaview and Kirrama Range, the southern Atherton and Evelyn Tablelands, the Lamb Range and the Carbine, Finnegan and Thornton uplands.

Cassowaries on Cape York Peninsula historically extended from just west of the tip of the Cape (at the mouth of the Jardine River) and down the east coast to at least as far south as Massey River (Thomson 1935) and probably further south into the Princess Charlotte Bay area (QPWS 2003). Cassowaries are known today from all historical sites with the exception of those in the far north. Cassowaries are suspected to have disappeared from the Lockerbie Scrub near Bamaga, as there have been no sightings since 1986 (QPWS 2003). Cassowaries on Cape York occur as two disjunct populations: a southern population centred on the vine forests of the MacIlwraith and Iron Ranges and a northern population centred on the much less extensive vine forests north of Shelburne Bay (Appendix 4: Figure 1). Vine-forests are very poorly developed south of the Princess Charlotte Bay area (Neldner and Clarkson 1995) and it is likely that the Cape York cassowary populations have been disjunct from the Wet Tropics population since well before the arrival of Europeans.

In 1988 the Wet Tropics population was estimated at between 2500–4000 adults (Crome and Moore 1990), by 2001 it was estimated at less than 1500 (Moore and Moore 2001). These estimates have been based on extrapolated survey data from several focal area studies (Moore and Moore 1999a, c, d, f; Moore and Moore 2001) but there are no detailed descriptions of the process used to arrive at Wet Tropics-wide estimates.

Habitat critical to the survival of the species

As a significant amount of cassowary habitat has been lost through clearing, all remaining habitat utilised by cassowaries is considered important. Three categories of habitat utilised by cassowaries

have been identified and mapped in the Wet Tropics by EPA (see Appendix 4: Figure 2) and are based on the Regional Ecosystem (RE) mapping. While three categories have been defined (see Appendix 3) it is the category of 'essential habitat', defined as being necessary for the persistence of cassowary populations in perpetuity, that is deemed to be the best estimate of habitat critical to the survival of the species. Essential cassowary habitat has been afforded protection under the VM Act and is the priority target for protection in this plan.

More than 800,000ha of essential cassowary habitat has been mapped in the Wet Tropics of which 84 per cent falls within the Wet Tropics World Heritage Area (WHA). While the majority of habitat lies within protected tenures (including both the WHA and the EPA estate) 11 per cent exists outside these areas, primarily on freehold land. In all, 91 RE types comprise essential habitat, the majority of which are rainforest.

Preliminary mapping of cassowary habitat on Cape York has been undertaken (QPWS 2003) but this is subject to further analysis and adoption of the method used in the Wet Tropics mapping. On Cape York, 98 per cent of all cassowary records that could be confidently associated with a habitat type were from seven vine forest types (after Neldner and Clarkson 1995). The majority of records are from mesophyll forest types (43 per cent) and notophyll vine-forest (24 per cent). The extent of vine forest on Cape York in which cassowaries have been recorded is 488,547ha (QPWS 2003).

Important populations

Crome and Moore (1990) identified areas of high cassowary activity or 'hotspots' around Mission Beach, Coquette Point (Moresby Range), Graham Range, Woopen/Badgery Creeks (upper Russell and North Johnstone River valleys), and the Wallaman Falls/Mt Fox areas. They further suggested that the Black Mountain corridor (Macalister Range), the Lamb Range to Davies Creek and the slopes on the north and east shores of Lake Tinaroo, appeared to be important for cassowary populations. Six priority Regional Cassowary Management Areas are identified as having extreme current/potential threats to their cassowary populations (see Moore and Moore 1999a, c, d, e, f). They are the Daintree lowlands, Kuranda and Black Mountain Road, sections of the Cairns foothills, Innisfail, Mission Beach and Paluma/Mt Spec.

Given their spatial and probable long-term temporal isolation from one another, the Wet Tropics and Cape York populations might well represent distinct genetic populations, but no population genetics data exists to confirm this. There appear to be at least ten subpopulations that have become isolated by clearing in the Wet Tropics (Garnett and Crowley 2000; QPWS 2002).

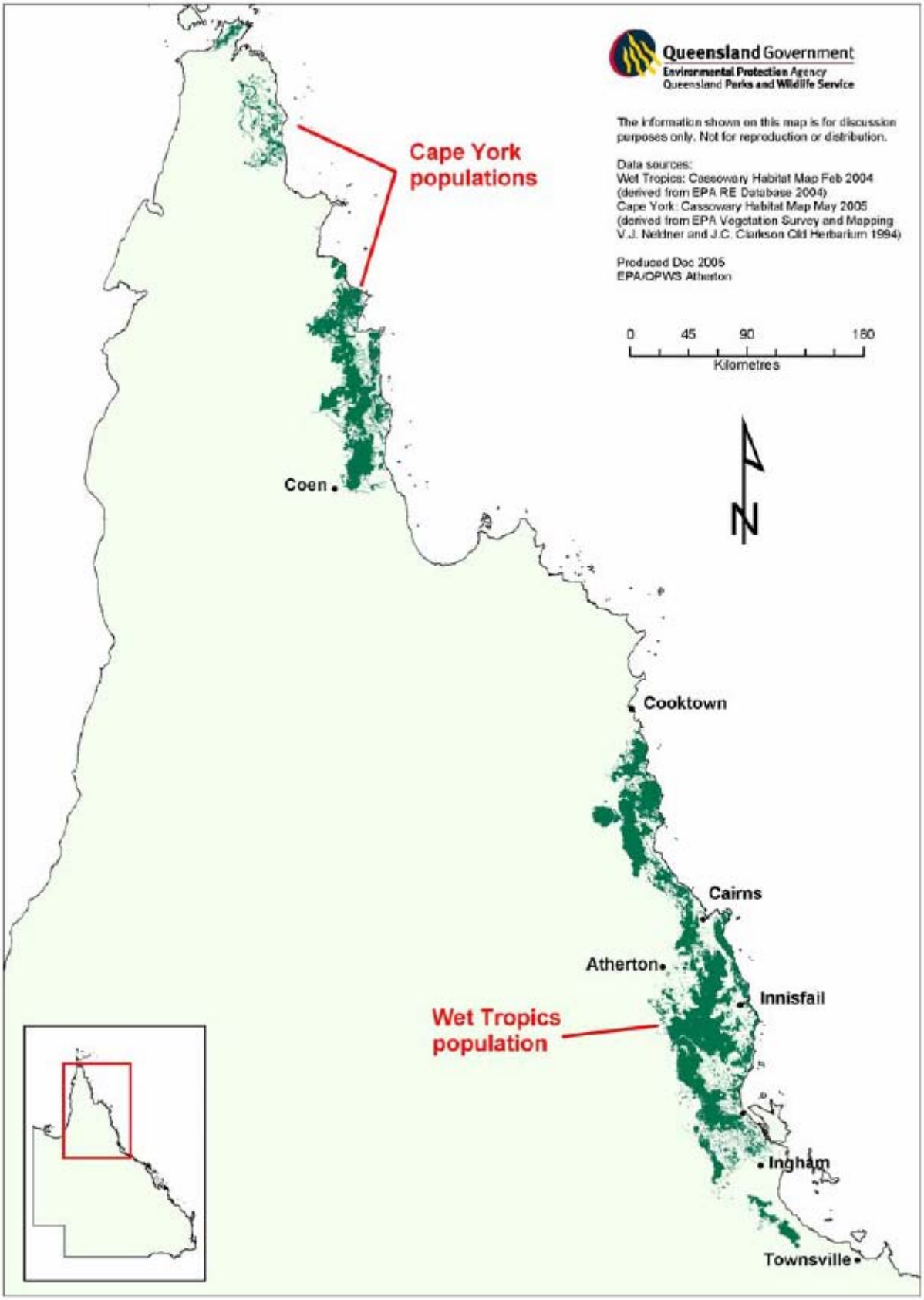

Figure 1: Distribution of cassowary habitat in Australia

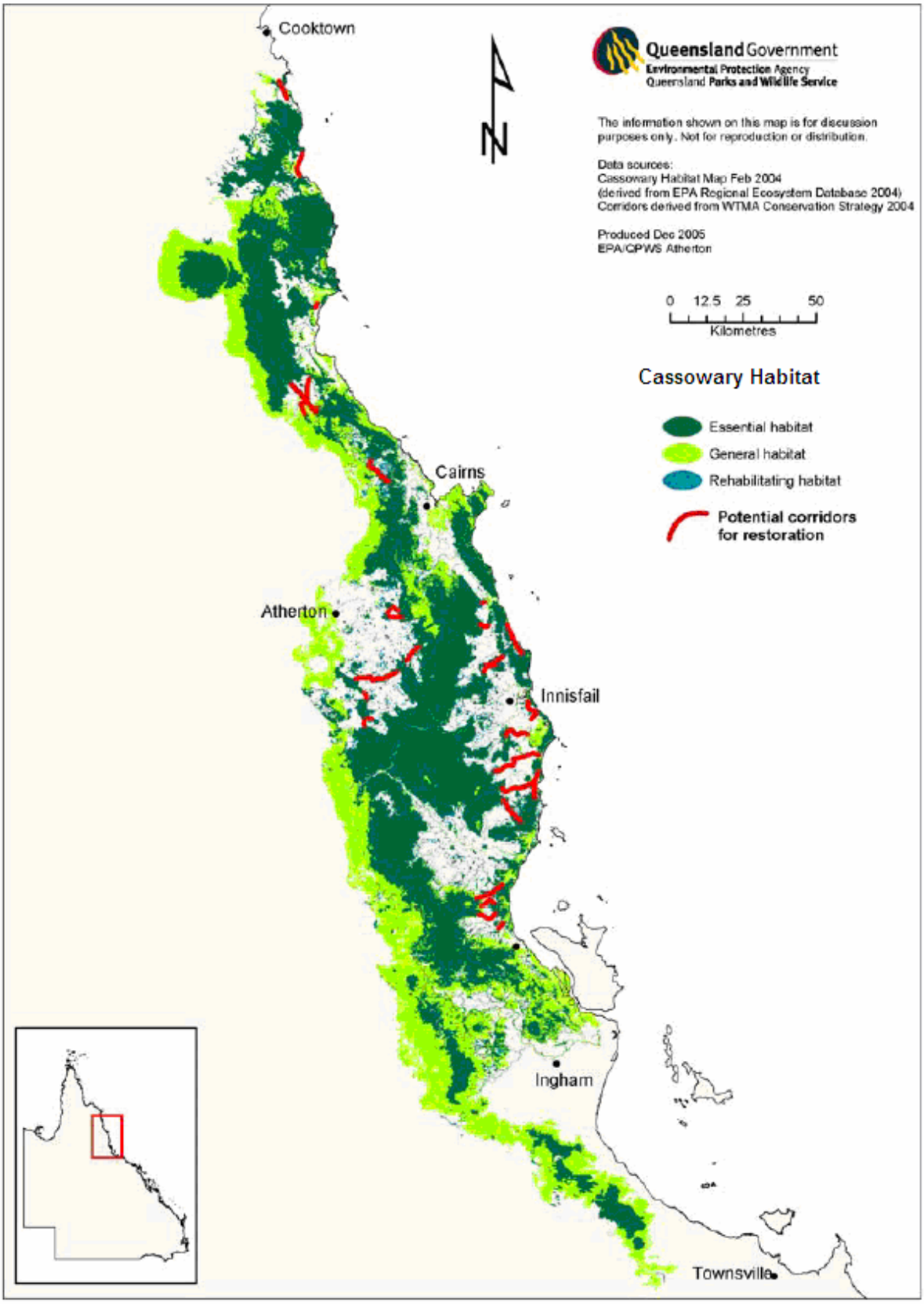

Figure 2: Distribution of cassowary habitat Wet Tropics

3. Threat0.s

Biology and ecology relevant to threats

It is difficult to assess the impact of threats to cassowaries when comparatively little is known of their ecology and behaviour, as well as use of fragmented habitats, immigration and birth rates. The extent and pattern of cassowary movement and remnant use is probably dependent on broader landscape patterns such as size of remnants available and the landscape context, type of vegetation in the remnant, proximity of other remnants and intact habitat, presence of other birds, food sources and fruiting phenology.

For small isolated populations there may be no substantial recruitment of new individuals due to available habitat occupied by adults and increased mortality of chicks and juveniles caused by dogs and cars. A lack of area suitable for juveniles to forage away from resident adults will also increase pressures on available resources, reducing the capacity of the local population to withstand cycles of environmental stress, for example, periods of low fruiting. The genetic health of isolated populations may be compromised by the effects of genetic drift and the loss of viability due to inbreeding depression.

Cassowaries are solitary, long-lived, slow-reproducing animals with lengthy parental care and probable low natural juvenile survival. The slow recruitment rate of cassowaries makes it difficult to determine the long-term viability of isolated populations. The persistence of individuals in patches of remnant habitat may not necessarily mean that the population is viable and will persist long-term.

Management responses such as the selective re-introduction of captive reared cassowaries is likely to be problematic, given that potential 'unoccupied' sites are unlikely to support any new birds reintroduced there. Therefore captive breeding for larger scale recovery release purposes is unlikely to be viable.

Identification of threats

Known and potential threats to cassowaries in the Wet Tropics area are well documented (Crome and Moore 1990; Garnett and Crowley 2000; QPWS 2002). Many threats are localised and don't operate across the extent of cassowary distribution. For example, road mortality tends to be a major issue in those areas where substantial urban/peri-urban development encroaches into cassowary habitat. Some threats target particular age groups; subadults and chicks, for example, are the most vulnerable to dog attack. Other factors such as habitat fragmentation may cause birds, particularly dispersing subadults, to travel further to access food and new habitat therefore increasing the risk of road mortality for that age class.

Little is known about the status of the Cape York population. Habitat is largely intact and not threatened by clearing and mortality from vehicle strikes or domestic dogs is unknown. Hunting may have contributed to the decline of cassowaries in the Lockerbie Scrub area, but it is not considered to be a threat at present (QPWS 2003). More information is required to determine the status of, and threats to, the Cape York population.

Habitat loss

The major threat to the long-term survival of Wet Tropics cassowaries is clearing and fragmentation of habitat. Vegetation loss is most extensive in the lowlands. By 1983, 57 per cent of lowland rainforest had been cleared with most of the rest highly fragmented (Winter et al. 1987). By 1997, 81 per cent of native vegetation had gone. In the past decade, clearing rates have slowed from 3000ha to 1000ha a year but are relatively constant (DNRM 2005).

While Wet Tropics Vegetation Management Codes regulate clearing, housing development still threatens local populations as supporting habitat is cleared. In Mission Beach incremental losses to severely fragmented habitat may eventually destroy the viability of the local population. Even low density housing brings more traffic and dogs. As small incremental habitat loss is a major threat, it warrants more attention in the planning process.

Habitat fragmentation
Habitat fragmentation resulting from clearing disrupts movement paths, may segregate feeding and breeding sections of an individual's range, and could lead to genetic isolation and local extinctions. The presence of a cassowary in an isolated forest patch does not indicate a secure local population. Cassowaries may persist but no longer breed or sub-adults might not survive. Crome and Moore (1988, 1990) have documented disappearance or severe decline in several forest patches. This process is evident on coastal lowlands, such as Moresby Range (Moore 1999d) and Mission Beach (Moore and Moore 2001).

Habitat degradation
Selective logging, weed invasion and disturbance to rainforest by changed fire regimes are all considered factors that degrade habitat quality for cassowaries, by decreasing shelter and degrading breeding sites and food sources. Crome and Moore (1988) suggest that cassowaries can tolerate some structural damage to their habitat and that an intermediate level of damage, particularly that which promotes high species diversity, may favour them. Severe fires can progressively destroy rainforest on steep slopes, however the maintenance of sclerophyll communities utilised by cassowaries is dependant on the presence of fire.

Pond apple, *Annona glabra*, one of the most threatening environmental weeds of the Wet Tropics (Werren 2001) has invaded a wide range of cassowary habitat. It is a semi-deciduous woody tree that forms dense thickets. Where pond apple dominates a community it replaces a diverse annual cycle of fruits with a single species, rendering the area unsuitable for cassowary foraging for all but the pond apple fruiting season. As the pond apple fruit is an attractive food source for cassowaries, they aid in its dispersal thus exacerbating its spread (Setter et al. 2002). When cassowaries feed on pond apple along main roads the risk of vehicular strike is significantly increased (A&RMCANZ 2001).

Roads and traffic
Some 3777km of highways, roads and tracks criss-cross the Wet Tropics World Heritage Area (WTMA 2004). Roads fragment habitat, create barriers to cassowary movement, produce edge effects, introduce exotic species and cause substantial mortality through direct strikes. Roads are also precursors to future impacts, because they often facilitate land development and the further expansion of the road network itself. Crome and Moore (1993) found that the home ranges of approximately half of the cassowaries in the Daintree lowlands are intersected by roads. Most other significant cassowary population areas such as Mission Beach are also either fragmented or surrounded by roads.

Because of its fragmented distribution, road mortality is likely to have highly significant impacts on the cassowary population. During 2001–05 28 cassowaries or 76 per cent of the total cassowary deaths recorded at Mission Beach were killed on roads (QPWS unpublished data). Given that cassowaries are long-lived, slow-reproducing animals with lengthy parental care and low juvenile survival, each road death of an adult bird may potentially influence population dynamics and the population's reproductive fitness (Bentrupperbäumer 1998).

Dogs
Dog attacks on cassowaries are known to cause injury and death and their presence potentially affects cassowary feeding, movements and behaviour (Crome and Moore 1988; Crome and Moore 1990). After vehicle strikes, dog attack may be the second most important recorded source of cassowary mortality (Bentrupperbäumer 1998; QPWS unpublished data). Of the six recorded cassowary deaths attributed to dog attack at Mission Beach between 1992–2005, five were subadults or chicks. Mortality in these age groups could be a significant impediment to recruitment in cassowary populations.

It is difficult to quantify the threat dogs pose. Actual deaths could be higher as attacks may go undetected or unreported. Without controls on roaming and adequate education on responsible pet ownership, the potential impact of dogs may be substantial in and near residential areas.

Pigs
Feral pigs are a major Wet Tropics pest and significant threat to World Heritage values (WTMA 2004). However, there is no evidence that feral pigs adversely affect cassowary survival (McIlroy 2001; DEH 2005). They reportedly destroy nests and eat cassowary eggs (Crome and Moore 1988; Crome and Moore 1990; Mitchell 1993; Mitchell 2000) but the significance is unknown. Cassowaries raise chicks every year in Wet Tropics areas with large pig populations (e.g. Jarra Creek and Cowley beach), predation on eggs or chicks may have little impact on populations (S. Burnett unpub. data).

Pigs may compete for food but how much they eat or disperse seed is unclear. Pigs degrade habitat and water quality by wallowing and rooting around watercourses and swamps. As cassowaries depend on fresh water for daily drinking and bathing (Bentrupperbäumer 1998), changes in water availability and quality could threaten populations.

Human Interaction
Hand-feeding of cassowaries is a risk to both birds and humans, and despite being illegal (Queensland *Nature Conservation Regulation 2006)*, people still feed them. Wild cassowaries conditioned to human food sources can be aggressive when protecting or seeking other human food. Regularly fed birds may then become a hazard. Of 150 recorded incidents (Kofron 1999) of cassowary attacks on humans, 75 per cent were known or suspected as being feeding-related.

As birds become less wary of humans, they may become more vulnerable to dog attack and road mortality as they move around looking for food. Hand-feeding at roadsides by people results in cassowaries being attracted to roads and consequently hit by traffic. Birds have also been observed to congregate in areas when artificially fed on a regular basis (QPWS unpublished); the impact this has on the ecology and social dynamics of the population is not known.

Disease
The possibility of avian diseases in cassowaries is serious given worldwide evidence that wildlife diseases pose a growing threat in conservation biology (Daszek et al. 2000; Daszak et al. 2001). It may become a management issue particularly for local populations under stress (Crome and Moore 1990). Known diseases include internal parasites (particularly ascarids), aspergillosis, *Aspergillus fumigatus*, and avian tuberculosis (TB), *Mycobacterium avium*. Immature birds (8–12 months) could be most affected (Dr Annabelle Olsson pers. comm).

Avian TB is a ubiquitous disease with the organism found in the environment including soil and water. A chronic wasting disease, it has been diagnosed post mortem with six recent cases (2002–05) in Mission Beach and Atherton Tablelands areas (QPWS unpublished data). Aspergillosis, the most common mycotic infection of the respiratory tract in birds is possibly a secondary disease of debilitated cassowaries causing respiratory symptoms and ultimately mortality (Romer 1997). Because aspergillosis is an opportunistic infection, stress and malnutrition may contribute to immunosuppression and increased susceptibility to the disease (Oglessbee et al. 1997).

Natural catastrophic events
Tropical cyclones are an integral part of the natural history of north Queensland (Webb 1958; Unwin et al. 1988). Webb (1958) estimated that none of the rainforests of the lowlands and foothills of north Queensland could escape severe or general cyclone damage for more than 40 years. Two severe cyclones since the mid 1980s have caused considerable and widespread disturbance to cassowary habitat; Cyclone Winifred in 1986 and Cyclone Larry in 2006. Extensive disturbance to coastal lowland habitat by Winifred is documented (Unwin et al. 1988) while preliminary assessment of Cyclone Larry impacts indicates considerable damage to forest structure far greater and more widespread than that of Winifred (QPWS unpub.data). Although vegetative recovery of forests appears rapid and widespread following cyclones (Unwin et al. 1988; Applegate and Bragg 1992), fires and weed invasion in disturbed areas potentially places habitat at further risk of degradation. There is little empirical evidence of the impact of cyclones on cassowary populations but observations of structural damage to habitat suggest the impact could be considerable. Cyclonic events will continue to adversely affect cassowary populations. Particularly small and

fragmented populations that are vulnerable to threats posed by development, isolation and other pressures.

Areas and populations under threat

Eight key Wet Tropics areas identified in the Cassowary Recovery Plan 2001–05 (QPWS 2002) are still seriously threatened by development pressures. Populations in these areas are therefore considered to be under the greatest threat.

- Mission Beach
- Daintree/Mossman lowlands
- Kuranda/Black Mountain corridor
- Cairns hill slopes
- Mulgrave Valley/Malbon-Thompson Range
- southern Atherton Tablelands
- Graham/Palmerston/Moresby Range
- Kennedy Valley/Murray River floodplain

The Cape York populations are considered to be under less threat than the Wet Tropics population (QPWS 2003) but a more detailed assessment is needed.

4. Evaluation of previous recovery plan

This recovery plan is a revision of the Recovery plan for the southern cassowary *Casuarius casuarius johnsonii* 2001–05. The overall objective of the previous recovery plan was to secure and enhance the status of the cassowary through an integrated programme of investigations, on ground management, public awareness raising and capacity building during the life of the plan. The following is an overview of the outcomes of the previous actions.

Action 1.1: Identify priority areas for protection

This action was implemented by developing a Wet Tropics cassowary habitat map. This map is being used by state and local government in assessing development applications. The 11 per cent of cassowary habitat currently falling outside protected and world heritage areas (mainly on freehold land) now receives priority conservation action.

Action 1.2: Restore linkages to reverse the problems of habitat fragmentation

Linkages and corridors were identified as part of the planning process for the Wet Tropics Conservation Strategy and through the habitat mapping process. These linkages are informing community driven restoration projects. Australian Rainforest Foundation is funding development of a detailed corridors plan for Mission Beach. At a local government level work has commenced on identifying key core habitat areas and linkages and developing strategies to rehabilitate and protect them. Much community restoration work on cassowary corridors has been completed through the Australian Government-funded projects in the coastal lowlands and on the Atherton Tablelands.

Action 1.3: Incentives to protect cassowary habitat on private lands

More cassowary habitat has been protected under the Nature Refuge programme, which provides landholders with support and opportunities to obtain funding for management of their properties.

Action 1.4: Memorandum of Understanding between State Government departments

State government agencies have been actively involved in the recovery of the cassowary. The Queensland Department of Main Roads (QDMR) has erected extensive signage, reduced speed limits and implemented traffic calming. QDMR, with support from EPA, is also funding the monitoring of a trial cassowary-crossing culvert at Mission Beach. The Queensland Department of Natural Resources and Water (DNRW) has also been involved in cassowary recovery through feral pig control programmes.

Action 2.1: Management of road mortality
In response to cassowary road mortality issues at Mission Beach, the QDMR erected extensive signage, reduced speed limits and implemented traffic calming. The Cassowary Management Strategy for Tully–Mission Beach Road is seen as a model for future road management work. QDMR, with support from EPA, is also funding the monitoring of a trial cassowary-crossing culvert at Mission Beach. Identification and monitoring of cassowary crossing points and cassowary 'black spots' is being undertaken by EPA. All road strikes, injuries and deaths reported to EPA are entered into a database.

Action 2.2: Dog control
Various community organisations and local councils have promoted information identifying the detrimental affect of dogs attacking or disturbing cassowaries. Local residents have been encouraged to control roaming dogs by EPA through the 'Be Cass-O-Wary' programme and by other organisations.

Action 2.3: Pig control
Feral pig control programmes continue to be implemented by DNRW.

Action 2.4: Cassowary rescue programme
EPA continues to manage a successful cassowary rescue, rehabilitation and release programme with rehabilitation facilities at Mission Beach and Hartley's Creek Crocodile Farm. EPA has the lead role in responding to cassowary incidents. Procedures are in place to respond to any sick, injured or killed cassowary. Comprehensive training for staff has been provided in all aspects of cassowary emergency response, handling and transport procedures. Translocation of successfully rehabilitated sick or injured birds continues and problem birds have also been successfully translocated.

Action 3.1: Cassowary population monitoring
Effective population monitoring has been constrained by lack of population monitoring techniques. EPA and CSIRO have begun the development of a faecal DNA identification technique and this technique will be progressed in this plan. The use of camera traps as a remote survey and monitoring technique has been extensively trialed in the Wet Tropics and Cape York. This technique proved problematic and was not pursued. The technique relied on taking high quality, profile photos of the cassowaries for accurate identification, however it was difficult to consistently obtain such images.

Information relating to cassowary sightings and incidents continue to be maintained by EPA in a GIS-based database. This database informs management decisions such as habitat distribution mapping, development assessment and other planning matters. The database records data on sightings and on sick, injured or dead cassowaries as well as post mortem results and cassowary/human incidents.

Action 3.2: Education, communication and community action
Through the efforts of the Cassowary Advisory Group, EPA and WTMA cassowary recovery receives comprehensive publicity via the print, electronic and broadcast media. In response to incidents involving cassowary/human interactions and the need for a more consistent and overarching framework for the delivery of cassowary conservation messages generally EPA has developed a cassowary education strategy. Through the theme 'Be Cass-O-Wary' the message of 'never feed cassowaries' is actively promoted. Brochures and posters have been produced and disseminated through local communities. Television Community service announcements supported by WTMA and the CAG outlining the no feeding message have been broadcast. Temporary signage about the issues of feeding and the consequences for doing so have been placed in areas where feeding is suspected.

A cassowary education kit has been developed by WTMA and the Cassowary Advisory Group and has been distributed through schools in the Wet Tropics.

Interpretation material has also been produced and is displayed by ARAZPA member zoos and wildlife parks to promote cassowary conservation.

Action 3.3: Indigenous community involvement
Aboriginal communities in the Wet Tropics and Cape York have been engaged in recovery actions. 'Cassowary and Culture' posters have been developed, distributed and promoted through Cape York Aboriginal communities. Girringun Aboriginal Corporation has developed a short educational film/documentary about the cassowary including aspects of its cultural significance to the rainforest Aboriginal people as well as scientific information about the cassowary.

Action 3.4: Recovery coordination
This recovery plan has been effectively coordinated to achieve the objectives set.

Action 4.1: Population assessment techniques
The use of camera traps as a remote survey and monitoring technique was extensively trialed in the Wet Tropics and Cape York. This technique proved problematic and was not pursued.

Action 4.2: Population trends and effects of different threats
Information on cassowary sightings and incidents continue to be maintained by EPA in a GIS-based database. An honours project has been developed to investigate the mortality of sub-adults at Mission Beach. The ecological significance of the cassowary as a disperser of seeds in the landscape is the subject of a major CRC Rainforest project (CSIRO/EPA). Results are currently being prepared for publication with one significant paper published (Westcott et al. 2005). Research will continue to inform future recovery actions.

5. Recovery objectives, Performance Criteria and Actions

Overall objective:

To secure the long-term protection of cassowary populations through improved planning mechanisms supported by robust monitoring, threat abatement and community engagement programmes.

Specific objective 1: Protect essential cassowary habitat and landscape corridors

Action 1.1 Complete mapping of essential cassowary habitat
Performance criterion 1.1 Cassowary map updated for the Wet Tropics and Cape York populations

Essential cassowary habitat in the Wet Tropics has been mapped and is based on the Queensland Herbarium Wet Tropics Interim Regional Ecosystem (RE) 1:100,000 mapping Version 4. With the release of Version 5 of the Wet Tropics RE mapping, a priority action is to update the cassowary map in line with this new RE coverage. Preliminary mapping of Cape York cassowary habitat (QPWS 2003) is subject to further analysis and adoption of the Wet Tropics mapping methodology (see Kutt et al. 2004).

Potential contributors: EPA, WTMA, CYNRM, Terrain NRM

Action 1.2 Identify and prioritise areas of essential habitat for protection and management
Performance criterion 1.2 Essential habitat areas assessed and assigned a priority ranking

EPA mapping identifies essential cassowary habitat but not local or regional areas targeted for cassowary conservation. The map serves as a baseline for more detailed plans. Once Action 1.1 is complete, priority conservation areas will be identified and appropriate conservation recommended. Data to be considered includes fragmentation and other threats, cassowary ecology, and planning issues such as land tenure, development pressures and regional ecosystem conservation status.

Assessment will build upon completed work (e.g. Moore and Moore 1999a,c,d,e,f). Assessment criteria will be developed to ensure that a consistent and defensible approach is taken to priority ranking. The priority assessment process will be based on GIS and field-derived data. This action will underpin development of Local Area Cassowary Conservation Plans (see Actions 2.2 and 2.3) or other possible planning instruments.

Potential contributors: EPA, WTMA, Terrain NRM, ARF, local councils, CAG, community groups

Action 1.3 Identify and prioritise habitat corridors for protection, restoration and management
Performance criterion 1.3 Priority habitat corridors identified, mapped and assigned a conservation priority ranking

To link isolated cassowary populations, a network of corridors needs to be established. Local governments have started identifying core habitat areas and links, and rehabilitation and protection strategies. With Australian Government funding, communities have restored many corridors in coastal lowlands and the Atherton Tablelands.

Broad landscape links identified under Wet Tropics Regional Vegetation Management Codes and in the Wet Tropic Conservation Strategy (WTMA 2004) form the basis for the 25 landscape corridors in this plan. These corridors are north/south, and broadly east/west between coastal habitats and footslopes and ranges (Appendix 4: Figure 2). Detailed macro-scale corridor plans are needed to identify specific areas for protection, restoration and management. Combined with Action 1.2, these plans will help develop Cassowary Conservation Local Area Plans. A monitoring programme will be established to assess effectiveness of corridors (Action 5.4). Information from appropriate genetic analysis (Action 6.2) may be informative about population connectivity afforded by existing and planned corridors.

Potential contributors: EPA, DNRW, ARF, Terrain NRM, CYNRM WTMA, CSIRO, ARF, local councils, community groups,

Action 1.4 Investigate strategies to conserve cassowary habitat on private lands
Performance criterion 1.4 Conservation measures for private land identified and additional areas of cassowary habitat are protected and being managed by landholders

Recovery will be more effective if habitat and connecting habitat on private lands, particularly coastal lowlands, are also managed for conservation. Building on Actions 1.2 and 1.3 and Cassowary Conservation Local Area Plans, this action will investigate the adoption of appropriate strategies and conservation incentives to involve landholders in the management of cassowaries on their land. Non-regulatory financial incentives include grants, rate deferrals and rebates, conservation or management agreements, covenants, revolving funds and development benefits.

A number of initiatives are underway. The Australian Rainforest Foundation is developing different ways to assist landholders in cassowary conservation through the acquisition, covenanting and on-selling of cassowary habitat. EPA is negotiating nature refuges on properties supporting cassowary habitat. Several Wet Tropics shire councils have a rate deferral incentive scheme to encourage voluntary habitat retention. Terrain NRM has plans to research and implement financial incentives under the Wet Tropics NRM Plan.

Substantial liaison will be sought with the community to canvass opinion regarding incentives for the protection and management of significant habitat. Local authorities will be involved in documenting the best ways to maximise cassowary habitat protection through local planning schemes. These outcomes will indicate the level of funding required to achieve effective habitat conservation on private lands.

Potential contributors: EPA, CY Land and Sea Centres, CYNRM, Terrain NRM

Specific objective 2: Institute a more coordinated and stronger planning response to development issues in cassowary habitat

Action 2.1 Strengthen linkages with other planning mechanisms to ensure an integrated and more consistent approach to cassowary conservation
Performance criterion 2.1 Review of effectiveness of current planning instruments completed with recommendations implemented

A number of local, regional, state and national strategic NRM plans complement, support and/or guide development and implementation of cassowary recovery actions. These include:
- FNQ Regional Plan
- Wet Tropics NRM Plan
- Local government planning schemes
- Regional Coastal Management Plans
- Wet Tropics Conservation Strategy
- Wet Tropics Aboriginal Cultural and Natural Resource Management Plan *and*
- Draft Mahogany Glider Recovery Plan and the draft Mabi Forest Recovery Plan.

This action aims to better integrate cassowary recovery with natural resource planning and investment at the regional and local levels through improved consultation with stakeholders and promotion of the recovery plan as the major strategic document directing cassowary conservation effort. The recovery team will engage all planning bodies to develop a consistent approach to cassowary conservation. This process will also examine opportunities for sharing resources and for submitting shared competitive funding bids as opportunities arise.

This action will audit cassowary protection within local government planning and help develop better planning scheme mechanisms to protect cassowary habitat. The outcome will complement development of Cassowary Conservation Local Area Plans and Action 2.3.

Potential contributors: EPA, Terrain NRM, WTMA, local councils

Action 2.2 Develop and implement Cassowary Conservation Local Area Plans
Performance criterion 2.2 Three Cassowary Conservation Local Area Plans developed, endorsed by recovery team and implemented

This action provides a mechanism to build upon the outcomes of Actions 1.2, 1.3 and 1.4 to implement on-ground protection and conservation actions through a coordinated Cassowary Conservation Local Area Plan. These plans will be non statutory and rely on partnership arrangements between stakeholders. These plans will also build upon earlier regional cassowary management plans (e.g. see Moore and Moore 1999a, 1999c, 1999d)

The planning process will ensure all stakeholders are involved and that local issues are addressed within the context of broader cassowary conservation priorities. The local community will retain ownership of the plan. A local planning group should be formed for each area, comprising representatives from state and local government, community conservation groups, private landholders, Aboriginal groups and industry.

Plans will prioritise actions, assign costs and identify potential participants and funding sources. In the life of this plan it is envisaged that at least three plans be developed and implemented on a priority basis. A Mission Beach Local Area Plan is to be developed as a priority. Other plans will be developed and will be identified through Action 1.2.

Potential contributors: Terrain NRM, EPA, WTMA, ARF, local councils, community and conservation groups, Aboriginal groups, industry

Action 2.3 Investigate development of other statutory planning instruments to minimise impacts of development on cassowaries
Performance criterion 2.3 Report prepared outlining options for development of statutory planning instruments to minimise impacts of development on cassowaries

It is the preferred intent of this recovery plan to develop non-statutory mechanisms to protect and manage cassowary habitat and reduce threats through a consultative local planning process

(Actions 2.1 and 2.2). However in response to ongoing development pressures on habitat in some of the more urbanised areas the development of a new appropriate statutory planning instrument may also be required to ensure development is compatible with cassowary conservation.

One such instrument could be a State Planning Policy (SPP). Developed under the *Integrated Planning Act 1997* a SPP could provide a high level of direction and support to government and others called on to make planning decisions on development relevant to cassowary conservation. The anticipated outcome of a SPP would be to ensure that future development in cassowary habitat is compatible with conservation of the species. It may also provide protection measures to address issues arising from new developments including incremental habitat loss, the impacts of roads, dog control and the provision and protection of habitat links.

Potential contributors: EPA, WTMA, Department of Local Government, Planning, Sport and Recreation (DLGPSR), local councils, community groups

Specific objective 3: Implement strategies to protect cassowary populations by minimising the adverse impacts of roads, dogs, pigs and cyclone events

Action 3.1 Minimise cassowary road mortality and injury

Performance criterion 3.1 Strategies to minimise cassowary road mortality incorporated into road planning and construction and a monitoring programme established to evaluate cassowary road management strategies

Strategies for reducing road deaths at Mission Beach, Daintree and Kuranda were identified by Moore and Moore 1999 a,b,c, 2001. Based on this work, the Department of Main Roads (DMR) erected signs, cut speed limits and calmed traffic at Mission Beach as part of the Cassowary Management Strategy for Tully–Mission Beach Road (DMR 2001). This approach could be used as a model in planning, building, maintenance, upgrading – and public education. While many proposed DMR strategies such as under road crossing structures need more research, priority work will continue at all identified areas.

Driver behaviour, vehicle strike frequencies, cassowary crossing points and ‘black spots’ should be monitored. All strikes, injuries and deaths should be reported to EPA and entered into a database, with road-strike data analysed for population viability models. Where possible, monitoring will be integrated into Local Area Cassowary Conservation Plans.

Potential contributors: EPA, WTMA, Terrain NRM, DMR, local councils

Action 3.2 Implement appropriate dog control to minimise dog attacks on cassowaries

Performance criterion 3.2 Responsible dog ownership education programme developed and promoted in the community with support from local councils

Shire councils will be encouraged to adopt and enforce dog registration, control regulations and incentives to minimise the incidence of roaming dogs. Regulatory mechanisms and financial inducements will be investigated and appropriate methods will be provided and promoted to all shires throughout cassowary habitat. A responsible dog-ownership education programme will also be developed and promoted through community education. Educational material will be developed and public promotional campaigns initiated. Appropriate pig-trapping programmes will be encouraged to try to phase out pig hunting using dogs in cassowary habitat. An educational pamphlet will be produced for local shire councils.

Potential contributors: EPA, WTMA, Terrain NRM, CYNRM, councils, conservation groups.

Action 3.3 Assess potential impacts of pigs on cassowaries

Performance criterion 3.3 Impacts of pigs on cassowaries assessed

As recommended in the Australian Government’s *Threat Abatement Plan for Pigs* (DEH 2005) this action aims to quantify the impact of feral pigs on cassowaries and to determine the relationship between feral pig density and the level of damage. This action will:

- identify priority areas where cassowaries are known or perceived to be under threat from feral pigs
- develop and implement studies that aim to determine the impact of feral pigs on cassowaries in priority areas, and
- recommend the level of feral pig control required to reduce the impact to an acceptable level.

Potential contributors: EPA, DNRW, WTMA, research institutions, Terrain NRM, CYNRM

Action 3.4 Support existing planning and management strategies that target pests and weeds in cassowary habitat
Performance criterion 3.4 Audit of existing pest and weed plans complete and information provided to local government

Several NRM regional plans address the management of feral animals and weeds in cassowary habitat. Local governments have developed Pest Management Plans that identify and target major environmental weeds and pest animals likely to disturb and degrade habitat. These plans are being amalgamated into a Regional Pest Management Strategy by the Far North Queensland Regional Organisation of Councils (FNQROC).

This action will support priority actions from the Wet Tropics NRM Plan (FNQ NRM Ltd and Rainforest CRC 2004), Wet Tropics Conservation Strategy (WTMA 2004), FNQROC Regional Pest Management Plan and local government pest and weed management plans which help cassowary recovery. In support, an audit will be conducted of existing programmes to determine their effectiveness. A line of communication will be established to give relevant authorities the results of monitoring, research and other recovery actions. These results will include current Rainforest CRC research of the role of cassowaries as weed dispersers and how management can incorporate dispersal into weed control programmes.

Potential contributors: DNRW, local councils, Terrain NRM, CYNRM

Action 3.5 Manage threats arising from human–cassowary interaction
Performance criterion 3.5 EPA Cassowary Education strategy promoted, supported and evaluated

EPA has developed a cassowary education programme. Through the theme "Be Cass-O-Wary" the message of "never feed cassowaries" is promoted via brochures, posters and TV community service announcements supported by WTMA and the Cassowary Advisory Group. Temporary signage explaining the consequences of feeding have been placed where feeding is suspected.

Although regulation and enforcement were options, EPA has been proactive, choosing education, which is seen as a major tool in reducing human–cassowary interactions. These educational themes and messages will be emphasised through local planning. Anecdotal evidence points to a marked reduction in feeding at Mission Beach (QPWS unpublished. data). A formal evaluation of the effectiveness of this programme will start at the end of the plan.

Potential contributors: EPA, WTMA, research institutions, local councils, tourism organisations, zoological institutions

Action 3.6 Develop and implement if required a post-cyclone cassowary response strategy
Performance criterion 3.6 Post-cyclone cassowary response strategy developed

While catastrophic cyclone events are infrequent, this action will formalise a post cyclone response strategy to guide management response and assist recovery of affected local cassowary populations and their habitat. After Cyclone Winifred in 1986, a supplementary feeding programme was implemented. At a later stage this led to conflict problems as birds became reliant on 'free feeding' (Bentrupperbäumer 1998). In order to mitigate human–cassowary interactions and long-term food dependency issues immediately post Cyclone Larry in 2006, EPA responded with a strategic supplementary feeding programme aimed at drawing birds away from urban areas. Response should consider supplementary feeding issues, including appropriate length of time for

feeding and an exit strategy and other immediate on-ground management needs such as community engagement, assessment of habitat disturbance and monitoring of habitat and population recovery.

Potential contributors: EPA, WTMA, local councils

Specific objective 4: Progress an effective cassowary rescue, rehabilitation and release programme

Action 4.1 Continue to implement the cassowary rescue programme

Performance criterion 4.1 Cassowary rescue programme implemented and all rehabilitated animals released back to the wild

This action will build upon successful existing rescue initiatives and support a rescue programme for emergency response and care of injured and orphaned cassowaries. The primary aim of the action is to release rehabilitated animals back to the wild. The rescue and rehabilitation programme involves EPA, local cassowary conservation groups, schools, veterinarians and the Australasian Regional Association of Zoological Parks and Aquaria – Queensland Branch (ARAZPAQ).

EPA leads the response to cassowary incidents with policies and procedures to help sick, injured or killed cassowaries. It also trains staff in all emergency, handling and transport procedures. Cassowary Rescue Kits will still be available at appropriate EPA offices in the Wet Tropics species' range. Garner's Beach rehabilitation will continue as the major facility with support from Hartley's Creek facility.

Potential contributors: EPA, WTMA, ARF, ARAZPAQ, CAG, veterinarians, community groups

Action 4.2 Implement EPA translocation strategy

Performance criterion 4.2 Translocation of cassowaries implemented as per translocation strategy

Translocation is a difficult issue because of the probable low survival rate of cassowaries in occupied areas (they are territorial and maintain a distinct home range). Translocating birds will change the dynamics of both source and recipient populations. These difficulties also apply to rehabilitation and release of sick or injured birds, particularly after long-term care when other birds have resumed their territories.

As translocation is very expensive, requiring intensive monitoring for animal welfare and human safety, it is the last resort for problem or injured birds. EPA now has a comprehensive translocation guide for managing issues, choosing suitable habitat, minimising risks to wild populations and people, and post-release monitoring. EPA will continue to manage any translocation as required.

Potential contributors: EPA, ARAZPAQ, ARF, NRM bodies, research institutions

Specific objective 5: Cassowary populations are monitored to assess population size, trends and status

Action 5.1 Develop and implement a population survey methodology based on faecal DNA

Performance criterion 5.1 Faecal DNA extraction methodology completed and field tested at Mission Beach

The EPA, CSIRO and Curtin University are developing a faecal-DNA methodology that, if successful, will allow identification of individuals from dung. This technique may also assist determining relatedness and dispersal between populations and provide insights into habitat connectivity and restoration needs (relevant to Actions 1.3 and 5.4). This action aims to finalise a faecal-DNA extraction methodology and then conduct a field trial at Mission Beach (with Action 6.1). A survey methodology will be developed for application at local and regional scales. Local communities will be encouraged to participate in surveys and trained to collect, store and transport scats.

Potential contributors: EPA, CSIRO, ARF, Curtin University, community groups, zoological industry groups and institutions

Action 5.2 Establish and implement a monitoring protocol in key habitat areas
Performance criterion 5.2 Monitoring protocol established for all cassowary populations

Based on the outcomes of Action 5.1, survey and sampling techniques will be developed and applied throughout the species' range. A monitoring programme will be developed and implemented for both Wet Tropics and Cape York populations. Monitoring at spatial and temporal scales will depend on resources and funds. All data will be recorded in the cassowary database. Population trends will be assessed against database information and other sources. This action will also investigate northern and southern range limits of Cape York cassowaries, especially the incidence of birds north and west of Escape River and south of Massey Creek to Princess Charlotte Bay.

Potential contributors: EPA, CSIRO, Curtin University, WTMA, Terrain NRM, CYNRM

Action 5.3 Assess size of Wet Tropics and Cape York populations and develop population viability models
Performance criterion 5.3 Estimates of cassowary population sizes determined and PVA models completed

Building upon outcomes of Actions 5.1 and 5.2, this action should provide the first reliable population estimates of cassowaries in the Wet Tropics and Cape York and provide base-line data required for population viability modelling. A Population Viability Analysis (PVA) will be undertaken towards the end of this recovery plan and incorporate all relevant data collected through the life of the plan.

Potential contributors: EPA, CSIRO and other research institutions, ARF, Terrain NRM, CYNRM, community groups

Action 5.4 Monitor and assess the effectiveness of corridors in facilitating cassowary movement
Performance criterion 5.4 Monitoring programme established to assess role of restored corridors in facilitating cassowary movement

To assess the effectiveness of establishing corridors in facilitating cassowary movement, a monitoring, research and management programme will be established. It aims to determine corridor lengths, widths and resources needed for successful movement between fragments; presently these are unknown. It will develop techniques for long-term maintenance of habitat structure within the constraints of local land uses. It will use the population monitoring programme established in Action 5.2, as well as any relevant information on population genetic structure obtained in Action 6.2.

Potential contributors: EPA, CSIRO, Curtin University and other research institutions, ARF, Terrain NRM, CYNRM, community groups

Action 5.5 Maintain a cassowary database
Performance criterion 5.5 The cassowary sightings database maintained

EPA maintains a GIS based cassowary sightings database, which incorporates survey records as well as incidental and injured cassowary encounters. Updated regularly this dataset is routinely loaded onto the EPA WildNet database. The purpose of the database is to store and manage distribution and incidental sightings data for cassowary conservation purposes. This database is readily available to inform management decisions including cassowary habitat distribution mapping, development assessment and other planning matters. The database also records data on sick, injured or dead cassowaries as well as post mortem results and cassowary/human incidents.

The database will be maintained and expanded to incorporate monitoring data collected through Actions 5.1 and 5.2. EPA will maintain the database and associated survey reports. The need for the public to report cassowary sightings to the EPA will continue to be publicised and encouraged.

Potential contributors: EPA and research institutions.

Specific objective 6: Improve understanding of cassowary ecology and threats to its survival to better inform cassowary recovery

Action 6.1 Undertake a population study of cassowaries at Mission Beach

Performance criterion 6.1 Population study at Mission Beach completed with outcomes incorporated into planning decisions

Because urbanisation brings greater interaction between cassowaries and people, we need to learn more about their behaviour as individuals and as a population in response to habitat changes. This action will implement a population level study of cassowaries in the Mission Beach area. Basic ecological data will be documented with an emphasis on population ecology, space-use and behaviour. Data collected is to be used in a detailed threat analysis for the Mission Beach population, information that could be incorporated into population viability analyses. Establishing the study at Mission Beach, where wild and more 'urbanised' birds are found, would provide the opportunity to directly compare the behaviour, habitat use and ecology of these two categories of birds. In addition, it would allow for the identification of the characteristics of individual animals at risk of becoming problem birds and provide the opportunity to examine translocation outcomes.

The project will utilise DNA identification techniques, individual markings and radio- and satellite-telemetry to develop an individually identifiable cassowary population. Regular monitoring of known individuals along with genetic parentage and relatedness analysis based on faecal genotype data will then be used to provide base-line data on habitat and space use by individuals and the population, population dynamics, social system description, genetic and social mating systems and problem bird ecology. Community involvement in the project will be crucial and is to be encouraged.

Potential contributors: EPA, Curtin University and other research institutions, ARF, Terrain NRM, community groups

Action 6.2 Determine the population genetic structure of cassowaries

Performance criterion 6.2 Population genetic structure for cassowaries determined

Faecal-DNA analysis will be used to document the genetic structure of cassowary populations. A range of population genetic analyses of these data will help us understand the scale of population dispersal within Wet Tropics and Cape York populations, including the effectiveness of corridors in connecting cassowary populations (relating to Actions 1.3 and 5.4). This will be used in developing meta-population and population viability models of cassowary dynamics.

Potential contributors: EPA, research institutions, Terrain NRM, CYNRM, ARF

Action 6.3 Determine the survival rate and cause of mortality of subadults in different habitats

Performance criterion 6.3 Assessment of factors affecting survival rate of sub-adults completed

Incidental observations suggest that cassowaries are breeding but that most young birds die before recruitment to adult populations. For population modelling and long-term management, it is essential that mortality, recruitment rates and dispersal patterns of young in the wild be understood.

This action will investigate the importance of different mortality factors in sub-adult cassowaries from several populations. Information gathered with radio-telemetry, visual tracking and scat analysis would help to improve sub-adult survival and to identify areas for habitat corridors for dispersal. Initially this action will be part of the Mission Beach study (Action 6.1) but then expanded

to include representative sub-adult populations from other populations, from large habitat blocks and more isolated smaller fragments.

Potential contributors: EPA, research institutions, Terrain NRM, CYNRM, ARF

Action 6.4 Investigate prevalence of disease in cassowaries and the factors affecting its epidemiology

Performance criterion 6.4 Investigations into disease and its possible impact on cassowaries completed

Research into diseases that may affect cassowary populations is currently limited to autopsy of birds which have died as a result of illness or injury, as well as opportunistic examinations and sample collection of free-living birds brought in for treatment or translocation. From this limited data source, a preliminary reference range for haematological and plasma biochemical parameters has already been established and a catalogue of diseases initiated (Dr Annabelle Olsson pers. comm).

Data on known mortality will continue to be collected, added to the database and analysed. Whenever possible, post mortems will collect DNA samples, record cause of death, state of health and presence of parasites or disease. A new research project will determine the prevalence of avian tuberculosis and other diseases in local wild populations, and correlate infection rates with areas of significant habitat degradation and high human impact.

Potential contributors: EPA, WTMA, research institutions, veterinarians

Specific objective 7: Engage the community in cassowary conservation and education

Action 7.1 Involve community in cassowary conservation

Performance criterion 7.1 Level of community involvement in cassowary recovery implementation has measurably improved over the life of plan and public support for the conservation of cassowaries is increased

The cassowary has always attracted considerable local interest. Conservation groups and the Cassowary Advisory Group in the Wet Tropics have worked hard on cassowary issues and hands-on conservation for many years. They will continue to be supported. Landholders, communities and school will be encouraged to assist with research, monitoring and habitat rehabilitation efforts when implementing Local Area Plans.

Potential contributors: CAG, WTMA, EPA, Terrain NRM, CYNRM, community and conservation groups

Action 7.2 Promote and publicise recovery plan

Performance criterion 7.2 A range of public information and educational materials produced and disseminated to community

This action complements Action 7.1 and reinforces the EPA Cassowary Education Strategy 2005–07. It aims to raise awareness among communities, promote partnerships to enhance management and conservation of cassowaries and provide education-based guidelines for EPA staff when implementing cassowary education.

Print and electronic media will increasingly be used to present information on cassowary conservation. Educational projects promoting Aboriginal culture and cassowary conservation will be encouraged and supported. All existing printed material will be reviewed and evaluated as to their effectiveness and consistency of messages and updated if necessary. Up-to-date cassowary reference material should be collated and distributed to local libraries and other information providers throughout the area as well as to DEWHA, EPA, WTMA and local government websites. Where required, interpretive signage will continue to be installed at key visitor nodes.

Cassowaries are exhibited at a number of wildlife parks throughout Australia. The recovery team will work with ARAZPAQ members to review display/interpretive materials with the view to developing a more consistent interpretive strategy focusing on threats and recovery of the species.

Potential contributors: CAG, EPA, WTMA, Terrain NRM, ARAZPAQ, community conservation groups

Action 7.3 Ensure Aboriginal communities participate in all aspects of the recovery process
Performance criterion 7.3 Protocol established ensuring Aboriginal communities are involved in the recovery process and are active in cassowary recovery projects

Aboriginal people have close cultural links with their traditional country and the cassowary and therefore possess extensive and intimate knowledge of the cassowary, its habitat and its conservation. Aboriginal people wish to be actively involved in the management and protection of the cassowary and its habitat through co-management arrangements, collaboration on research and monitoring and involvement in projects on country to rehabilitate and protect cassowary habitat. Aboriginal participation in all aspects of cassowary recovery can result in mutually beneficial sharing of knowledge.

A consultative protocol will be established from which the engagement of Aboriginal communities in the recovery plan will be directed. This will require comprehensive negotiation and consultation with Aboriginal communities to ensure their effective participation. The recovery team will continue to engage regional Traditional Owner organisations such as the Aboriginal Rainforest Council and Girringun Aboriginal Corporation and support their roles in caring for their country and actions promoting the recovery of cassowaries.

Potential contributors: ARC, Girringun, CY Land and Sea Centres, Aboriginal communities, EPA, WTMA, Terrain NRM, CYNRM

Action 7.4 Document traditional cultural knowledge of cassowaries
Performance criterion 7.4 Traditional cultural knowledge of cassowaries documented and where negotiated incorporated into recovery plan projects

Aboriginal people have customs, stories, songs and dances about cassowary. Cassowaries are prized food, and their feathers, claws and bones are used for ornaments and hunting. The fact that cassowaries are now endangered is also of grave concern to rainforest Aboriginal people. As modern day pressures threaten the future of cassowaries, they also threaten the customs and traditions associated with cassowaries and impact on the long-term survival of rainforest Aboriginal people (Wet Tropics Conservation Strategy 2004, p30).

Aboriginal communities will be consulted about establishing a study to document the nature of relationships between Aboriginal communities and cassowaries and emphasise the role and importance of traditional knowledge in the management and recovery of this species. Under the guidance of the above study, the nature and possibilities of Aboriginal participation in cassowary management will be explored and documented through direct consultation with individual communities. Intellectual and cultural property protocols for collection, use, access and storage of information will be developed.

Potential contributors: ARC, Girringun, CY Land and Sea Centres, Aboriginal communities, EPA, WTMA, Terrain NRM, CYNRM

Specific objective 8: Manage the recovery programme

Action 8.1 Ensure recovery plan implementation is coordinated effectively
Performance criterion 8.1 Regular recovery plan meetings held with all stakeholders actively involved and supported

To guide implementation of this plan, a comprehensive implementation schedule will be developed by the Recovery Team upon the plan's approval. Implementation of this recovery plan will be

monitored and reviewed by the Recovery Team with additional input from the Cassowary Advisory Group (CAG) and the Cassowary Scientific Advisory Group CSAG. Both the CAG and the CSAG will continue to be supported and their respective roles in the recovery process actively promoted. Communication to stakeholders will be facilitated through the dissemination of meeting minutes, reports and other relevant information to Recovery Team, CSAG and CAG team members. Reporting will also be provided to relevant agencies and funding organisations. It is envisaged that recovery team members will actively promote the recovery plan as the major strategic planning tool for cassowary conservation through the respective organisations they represent.

Potential contributors: Recovery Team, CSAG and CAG, CYNRM, Terrain NRM

Action 8.2 Review the recovery plan
Performance criterion 8.2 An independent review of the recovery plan completed

The plan will be reviewed within five years to check progress of recovery and direct any necessary actions. Members of the recovery team will review and evaluate progress annually.

Potential contributors: Recovery Team

Table 4: Summary of relationship between objectives, performance criteria, actions and potential contributors.

P[a] = Priority ranking 1 = High priority, 2 = Medium priority, 3 = Low priority

Objectives	Performance Criteria	Actions	Potential contributors	P[a]
1 Protect essential cassowary habitat and landscape corridors	**1.1** Cassowary map updated for the Wet Tropics and Cape York populations	**1.1** Complete mapping of essential cassowary habitat	EPA, WTMA, CYNRM, Terrain NRM	**1**
	1.2 Essential habitat areas assessed and assigned a conservation priority ranking	**1.2** Identify and prioritise areas of essential habitat for protection and management	EPA, WTMA, Terrain NRM, ARF, local councils, CAG, community groups	**1**
	1.3 Priority habitat corridors identified, mapped and assigned a conservation priority ranking	**1.3** Identify and prioritise habitat corridors for protection, restoration and management	EPA, DNRW, ARF, Terrain NRM, CYNRM WTMA, CSIRO, ARF, local councils, community groups	**1**
	1.4 Conservation measures for private land identified and additional areas of Mabi Forest are protected and being managed by landholders	**1.4** Investigate strategies to conserve cassowary habitat on private lands	EPA, CY Land and Sea Centres, CYNRM, Terrain NRM	**2**
2 Institute a more coordinated and stronger planning response to development issues in cassowary habitat	**2.1** Review of effectiveness of current planning instruments completed with recommendations implemented	**2.1** Strengthen linkages with other planning mechanisms to ensure an integrated and more consistent approach to cassowary conservation	EPA, Terrain NRM, WTMA, local councils	**2**
	2.2 Three Cassowary Conservation Local Area Plans developed, endorsed by recovery team and implemented as funding is made available	**2.2** Develop and implement Local Area Cassowary Conservation Plans	Terrain NRM, EPA, WTMA, ARF, local councils, community and conservation groups, Aboriginal groups, industry	**1**
	2.3 Report prepared outlining options for development of statutory planning instruments to minimise impacts of development on cassowaries	**2.3** Investigate development of other statutory planning instruments to minimise impacts of development on cassowaries	EPA, WTMA, DLGPSR, local councils, community groups	**1**
3 Implement strategies to protect cassowary populations by minimising the adverse impacts of roads, dogs, pigs and cyclone events	**3.1** Strategies to minimise cassowary road mortality incorporated into road planning and construction and a monitoring programme established to evaluate cassowary road management strategies	**3.1** Minimise cassowary road mortality and injury	EPA, WTMA, Terrain NRM, DMR, local councils	**1**
	3.2 Responsible dog ownership education programme developed and promoted in the community with support from local councils	**3.2** Implement appropriate dog control to minimise dog attacks on cassowaries	EPA, WTMA, Terrain NRM, CYNRM, local councils, conservation groups.	**1**
	3.3 Impacts of pigs on cassowaries assessed	**3.3** Assess the potential impacts of pigs on cassowaries	EPA, DNRW, WTMA, research institutions, Terrain NRM, CYNRM	**3**
	3.4 Audit of existing pest and weed plans complete and information provided to local government	**3.4** Support existing planning and management strategies that target pigs and weeds in cassowary habitat	DNRW, local councils, Terrain NRM, CYNRM	**3**
	3.5 EPA Cassowary Education strategy promoted, supported and evaluated	**3.5** Manage threats arising from human-cassowary interactions	EPA, WTMA, ARAZPAQ, research institutions, local councils, tourism organisations	**1**
	3.6 Post-cyclone cassowary response strategy developed	**3.6** Develop and implement if required a post-cyclone cassowary response strategy	EPA, WTMA, local councils	**2**

Objectives	Performance Criteria	Actions	Potential contributors	
4 Progress an effective cassowary rescue, rehabilitation and release programme	**4.1** Cassowary rescue programme implemented and all rehabilitated animals released back to the wild	**4.1** Continue to implement the cassowary rescue programme	EPA, WTMA, ARF, ARAZPAQ, CAG, veterinarians, community groups	**1**
	4.2 Translocation of cassowaries implemented as per translocation strategy	**4.2** Implement a translocation strategy	EPA, ARAZPAQ, ARF, NRM bodies, research institutions	**1**
5 Cassowary populations are monitored to assess population size, trends and status	**5.1** Faecal DNA extraction methodology completed and field tested at Mission Beach	**5.1** Develop and implement a population survey methodology based on faecal DNA	EPA, CSIRO, ARF, community groups	**1**
	5.2 Monitoring protocol established for all cassowary populations	**5.2** Establish and implement a monitoring protocol in key habitat areas	EPA, CSIRO, WTMA, Terrain NRM, CYNRM	**1**
	5.3 Estimate of cassowary population sizes completed and Population Viability Analysis models completed	**5.3** Assess size of Wet Tropics and Cape York populations and develop population viability models	EPA, CSIRO and other research institutions, Terrain NRM, CYNRM	**2**
	5.4 Monitoring programme established to assess role of restored corridors in facilitating cassowary movement	**5.4** Monitor and assess the effectiveness of corridors in facilitating cassowary movement	EPA, research institutions, ARF, Terrain NRM, community groups	**2**
	5.5 The cassowary sightings database maintained	**5.5** Maintain a cassowary database	EPA	**2**
6 Improve understanding of cassowary ecology and threats to its survival to better inform cassowary recovery	**6.1** Population study at Mission Beach completed with outcomes incorporated into planning decisions	**6.1** Undertake a population study of cassowaries at Mission Beach	EPA, research institutions, ARF, Terrain NRM, community groups	**2**
	6.2 Population genetic structure for cassowaries determined	**6.2** Determine the population genetic structure of cassowaries	EPA, research institutions, Terrain NRM, CYNRM, ARF	**2**
	6.3 Assessment of factors affecting survival rate of sub adults completed	**6.3** Determine the survival rate and cause of mortality of subadults in different habitats	EPA, research institutions, Terrain NRM, CYNRM, ARF	**2**
	6.4 Investigations into disease and its possible impact on cassowaries completed	**6.4** Investigate the prevalence of disease in cassowaries and factors affecting its epidemiology	EPA, WTMA, research institutions, veterinarians	**3**
7 Engage the community in cassowary conservation and education	**7.1** Level of community involvement in cassowary recovery implementation has measurably improved over the life of plan and public support for the conservation of cassowaries is increased	**7.1** Involve the community in cassowary conservation	CAG, WTMA, EPA, Terrain NRM, CYNRM, community and conservation groups	**1**
	7.2 A range of public information and educational materials produced and disseminated to community	**7.2** Promote and publicise the recovery plan	CAG, EPA, WTMA, Terrain NRM, community conservation groups	**2**
	7.3 Protocol established ensuring Aboriginal communities are involved in the recovery process and Aboriginal communities active in cassowary recovery projects	**7.3** Ensure Aboriginal communities participate in all aspects of the recovery process	ARC, Girringun, CY Land and Sea Centres, Aboriginal communities, EPA, WTMA, Terrain NRM, CYNRM, ARAZPAQ	**1**
	7.4 Traditional cultural knowledge of cassowaries documented and where negotiated incorporated into recovery plan projects	**7.4** Document traditional cultural knowledge of cassowaries	ARC, Girringun, CY Land and Sea Centres, Aboriginal communities, EPA, WTMA, Terrain NRM, CYNRM	**2**
8 Manage the recovery programme	**8.1** Regular recovery plan meetings held with all stakeholders actively involved and supported	**8.1** Ensure recovery plan implementation is coordinated effectively	Recovery Team, CSAG and CAG, CYNRM, Terrain NRM	**1**
	8.2 An independent review of the recovery plan completed	**8.2** Review the recovery plan	Recovery Team	**3**

6. Management practices

A range of other planning mechanisms provide guidance for cassowary conservation and habitat management and include: the Wet Tropics FNQ Regional Plan, Wet Tropics NRM Plans, Local government planning schemes, Regional Coastal Management Plans, Wet Tropics Conservation Strategy.

Several Australian Government, State and local government planning mechanisms (e.g. EPBC Act, Local Government planning schemes, IPA, VMA) have a statutory basis and may place certain constraints on the development of cassowary habitat. Activities affecting cassowary habitat within the Wet Tropics World Heritage Area may require approval under the Wet Tropics Management Plan. Works such as road construction and upgrading or tree clearing are subject to a permit under the Plan.

Regional ecosystems identified as essential cassowary habitat are listed under the Wet Tropics Regional Vegetation Management Codes for Broadscale Clearing and for Ongoing Clearing Purposes. These codes regulate clearing on essential cassowary habitat and were prepared in accordance with provisions under the *Vegetation Management Act 1999*. The distribution of essential cassowary habitat will continue to be utilised for the assessment of tree clearing permits, tenure dealings and development applications under the codes. The mapping will be kept updated as a dynamic process, in line with any changes to the base layer, the Queensland Herbarium Wet Tropics regional ecosystem mapping.

Management requirements for cassowary habitat within EPA managed protected area estate include the maintenance of appropriate fire regimes and intervals (in sclerophyll habitat), the enhancement of wildlife corridors and weed and feral pig management. EPA continues to have the lead role in responding to any sick, injured or killed cassowary, responding to and managing any human/cassowary incidents and for the relocation of any identified dangerous cassowary. Through the theme 'Be Cass-O-Wary', the message of 'never feed cassowaries' is actively promoted by EPA as part of its cassowary education strategy.

7. Evaluation of recovery plan

Progress will be monitored and evaluated annually by members of the Recovery Team through an annual review. An independent external reviewer will be contracted to review and evaluate performance of the recovery plan.

8. Costs of recovery

Table 5: Estimated cost of recovery ($ per annum)

Action	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Total
1.1: Complete mapping of essential cassowary habitat	2000	3000	5000	5000	0	**15,000**
1.2: Identify and prioritise areas of essential habitat for protection and management	15,000	5000	0	0	0	**20,000**
1.3: Identify and prioritise habitat corridors for protection, restoration and management	15,000	10,000	10,000	0	0	**35,000**
1.4: Develop strategies to conserve cassowary habitat on private lands	0	5000	5000	10,000	0	**20,000**
2.1: Strengthen linkages with other planning mechanisms to ensure an integrated and more consistent approach to cassowary conservation	2000	2000	2000	2000	2000	**10,000**
2.2: Develop and implement Local Area Cassowary Conservation Plans	20,000	20,000	20,000	20,000	20,000	**100,000**
2.3: Investigate development of other statutory planning tools instruments to minimise impacts of development on cassowaries	10,000	10,000	10,000	0	0	**30,000**
3.1: Minimise cassowary road mortality and injury	5000	5000	10,000	10,000	10,000	**40,000**

Action	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Total
3.2: Implement appropriate dog control to minimise dog attacks on cassowaries	5000	5000	5000	2000	2000	**19,000**
3.3: Assess potential impacts of pigs on cassowaries	5000	10,000	5000	5000	5000	**30,000**
3.4: Support existing planning and management strategies that target pigs and weeds in cassowary habitat	5000	5000	5000	5000	5000	**25,000**
3.5: Manage threats arising from human-cassowary interaction	5000	5000	5000	5000	5000	**25,000**
3.6: Develop and implement if required a post-cyclone cassowary response strategy	5000	0	0	0	0	**5000**
4.1: Continue to implement the cassowary rescue programme	10,000	10,000	10,000	10,000	10,000	**50,000**
4.2: Implement a translocation strategy	5000	5000	5000	5000	5000	**25,000**
5.1: Develop and implement a population survey methodology based on faecal DNA	20,000	15,000	10,000	5000	0	**50,000**
5.2: Establish and implement a monitoring protocol in key habitat areas	0	0	15,000	15,000	15,000	**45,000**
5.3: Assess population size of WT and CY populations and develop population viability models	0	0	20,000	20,000	20,000	**60,000**
5.4: Monitor and assess the effectiveness of corridors in facilitating cassowary movement	0	5000	5000	5000	5000	**20,000**
5.5: Maintain a cassowary database	2000	2000	2000	2000	2000	**10,000**
6.1: Undertake a population study of cassowaries at Mission Beach	20,000	20,000	10,000	10,000	5000	**65,000**
6.2: Determine the population genetic structure of cassowaries	20,000	20,000	20,000	0	0	**60,000**
6.3: Determine the survival rate and cause of mortality of subadults in different habitats	5000	10,000	10,000	5000	0	**30,000**
6.4: Investigate prevalence of disease in cassowary populations and the factors affecting its epidemiology	5000	5000	10,000	10,000	10,000	**40,000**
7.1: Involve community in cassowary conservation	5000	5000	5000	5000	5000	**25,000**
7.2: Promote and publicise recovery plan	5000	10,000	20,000	10,000	5000	**50,000**
7.3: Ensure Aboriginal communities participate in all aspects of the recovery process	5000	5000	5000	5000	5000	**25,000**
7.4: Document traditional cultural knowledge of cassowaries	10,000	10,000	10,000	10,000	5000	**45,000**
8.1: Ensure recovery plan implementation is coordinated effectively	3000	3000	3000	3000	3000	**15,000**
8.2: Review the recovery plan	0	0	0	0	5000	**5000**
TOTAL ($)	**189,000**	**190,000**	**242,000**	**204,000**	**169,000**	**994,000**

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Appendices

Appendix 1. Recovery Team membership

Individuals from the following groups are members of the Recovery Team and contributed to the preparation of this recovery plan.

Environmental Protection Agency
Department of Natural Resources and Water
Cassowary Advisory Group representing community conservation groups
Cassowary Scientific Advisory Group
Wet Tropics Management Authority
Local governments
Australian Rainforest Foundation
Terrain NRM
Cape York Community Engagement Group
Aboriginal Rainforest Council
Cairns and Far North Environment Centre
Girringun Aboriginal Corporation
Australasian Regional Association of Zoological Parks and Aquaria - Qld

Appendix 2. Regional Ecosystems designated as Essential Cassowary Habitat in the Wet Tropics and their status under the Vegetation Management Act 1999

Regional ecosystems listed are from the Queensland Herbarium Wet Tropics Interim Regional Ecosystem 1:100,00 mapping (version 4) certified in August 2003.

VMA Status: E = endangered, OC = Of Concern, NOC = Not of Concern. Those REs with no designated status have yet to be assessed under the VMA

RE	Description	Remnant area (ha)	VMA Status
7.2.1	Mesophyll vine forest of very wet coastal lowlands on beach sands.	595.4	E
7.3.1	Sedgeland (Cyperus spp., Eleocharis dulcis, Baumea spp., Scleria poiformis) and grassland (Ischaemum villosum, Imperata cylindrica, Cynodon dactylon) freshwater swamps of seasonally inundated coastal lowlands.	1582.2	E
7.3.3	Alexandra palm (Archontophoenix alexandrae) swamp vine forest on very wet poorly drained fertile lowlands.	2587.6	E
7.3.4	Fan palm (Licuala ramsayi) swamp vine forest on very wet poorly drained seasonally inundated lowlands.	397.3	E
7.3.6	Mixed paperbark (*Melaleuca quinquenervia* and/or *M. leucadendra* and/or *M. dealbata*) open forest, often with a well developed understorey of vine forest species, on very wet poorly drained lowlands (palustrine wetland).	3240.7	E
7.3.7	Coastal floodplain forest red gum/melaleuca (Eucalyptus tereticornis/Melaleuca spp.) open forest complex on moist to very wet poorly drained lowlands.	1678.9	E
7.3.10	Complex mesophyll vine forest on very wet well drained fertile lowland alluvial soils.	7233.1	E
7.3.12	Forest red gum (Eucalyptus tereticornis) woodland, or popular gum (E. platyphylla) and Clarkson's blood wood (Corymbia clarksoniana) woodland on very wet to wet, well drained lowland alluvial soils.	2499.4	E
7.3.24	Red tea–tree (*Melaleuca dealbata*) riparian open forest on moist fertile moderately drained lowland alluvia.	295.4	E
7.3.27	Carbeen (*Corymbia tessellaris*), forest red gum (*Eucalyptus tereticornis*), swamp mahogany (Lophostem*on suaveolens*), red tea–tree (*Melaleuca dealbata*) riparian open forest on levees.	3634.4	E
7.8.2	Complex mesophyll vine forest on very wet basalt uplands.	7155.7	E
7.8.3	Complex notophyll vine forest on moist basalt lowlands, foothills and uplands.	1450.3	E
7.8.4	Complex notophyll vine forest on cloudy wet basalt uplands and highlands.	9854.6	E
7.8.7	Forest red gum (*Eucalyptus tereticornis*) tall open forest on moist basalt uplands and highlands.	7468.0	E
7.11.2	Mesophyll fan palm (*Licuala ramsayi*) swamp vine forest on very wet poorly drained metamorphic foothills and tablelands.	43.3	E
7.1.3	Bulkuru (Eleocharis dulcis) swamp on poorly drained acid peats.	686.8	OC
7.2.4	Open forest/woodland vegetation mosaic (Corymbia spp., Lophostemon suaveolens, Eucalyptus pellita, Acacia spp.) of wet lowlands on old stranded dune ridges on sands.	3736.1	OC
7.3.5	Swamp paperbark (*Melaleuca quinquenervia*) open forest on very wet and wet poorly drained lowlands (palustrine wetland).	11130.2	OC
7.3.11	Mesophyll vine forest with red stringybark (*Eucalyptus pellita*) emergents on very wet to wet well drained lowland alluvial soils.	870.5	OC
7.3.18	Mesophyll vine forest with pink bloodwood (*Corymbia intermedia*) emergents on wet to very wet well drained piedmont fans.	1493.6	OC
7.3.22	Mesophyll riparian vine forest on moist well drained lowland alluvial levees.	11418.2	OC
7.3.23	Notophyll to mesophyll riparian vine forest on dry well drained lowland alluvial levees.	7004.4	OC
7.3.25	Weeping tea-tree (Melaleuca leucadendra), M. fluviatilis, Moreton Bay ash (Corymbia tessellaris) open forest with notophyll riparian vine forest species, on levees.	283.7	OC
7.8.1	Complex mesophyll vine forest on very wet well drained basalt lowlands.	22654.4	OC
7.11.4	Mesophyll vine forest dominated by brown salwood (*Acacia celsa*) on very wet to wet metamorphic lowlands and foothills.	6422.2	OC
7.11.5	Simple mesophyll vine forest with red stringybark (*Eucalyptus pellita*) emergents on very wet to wet metamorphic lowlands and foothills.	4336.1	OC
7.11.6	Simple mesophyll vine forest with turpentine (*Syncarpia glomulifera*) emergents on very wet to wet metamorphic lowlands and foothills.	799.9	OC
7.11.10	Notophyll vine forest dominated by brown salwood (*Acacia celsa*) on very wet to wet metamorphic foothills, uplands and highland ridges.	6168.3	OC
7.11.11	Notophyll vine forest dominated by *Acacia cincinnata/Acacia polystachya* on wet metamorphic foothills and uplands.	3784.1	OC
7.11.14	Simple notophyll vine forest with rose gum (*Eucalyptus grandis*) emergents on moist metamorphic uplands.	3997.5	OC
7.11.18	Forest red gum (*Eucalyptus tereticornis*) woodland on wet to moist metamorphic foothills.	2668.3	OC
7.12.2	Fan palm (*Licuala ramsayi*) dominated mesophyll vine forest on very wet poorly drained granite foothills.	1.8	OC
7.12.3	Mesophyll vine forest with forest red gum (*Eucalyptus tereticornis*) emergents on wet to moist granite foothills.	1326.7	OC
7.12.4	Mesophyll vine forest with turpentine (*Syncarpia glomulifera*) emergents on very wet granite and rhyolite lowlands and foothills.	1269.9	OC

RE	Description	Remnant area (ha)	VMA Status
7.12.5	Simple mesophyll vine forest with red stringybark (*Eucalyptus pellita*) emergents on very wet to wet granite lowlands and foothills.	4677.0	OC
7.12.8	Complex notophyll vine forest with emergent bunya pine (*Araucaria bidwilli*) on moist granite uplands on yellow podzolic soils.	487.3	OC
7.12.13	Notophyll vine forest dominated by blackwood (Acacia melanoxylon) on cloudy wet granite and rhyolite uplands.	939.7	OC
7.12.17	Simple notophyll vine forest with cadaghi (*Corymbia torelliana*) emergents on moist granite and rhyolite foothills and uplands.	2890.2	OC
7.2.3	Dune ridge vegetation mosaic of coastal lowlands.	7379.2	NOC
7.3.8	Broad–leaf tea tree (*Melaleuca viridiflora*) woodland swamp complex on dry to very wet poorly drained lowlands and tablelands.	8585.5	NOC
7.3.17	Complex mesophyll vine forest on very wet well drained lowland and foothill piedmont fans.	10687.4	NOC
7.11.1	Mesophyll vine forest on very wet to wet metamorphic lowlands and foothills.	134409.4	NOC
7.11.7	Complex notophyll vine forest with kauri pine (*Agathis robusta*) emergents on moist metamorphic foothills and uplands.	38365.3	NOC
7.11.12	Simple notophyll vine forest on cloudy wet metamorphic uplands.	16319.9	NOC
7.11.13	Simple notophyll vine forest with forest red gum (*Eucalyptus tereticornis*) emergents on moist metamorphic foothills and uplands.	19757.4	NOC
7.12.1	Mesophyll vine forest on very wet to wet granite lowlands and foothills.	132113.7	NOC
7.12.7	Complex notophyll vine forest with emergent kauri pine (*Agathis robusta*) on moist granite foothills and uplands.	14690.1	NOC
7.12.9	Notophyll/mesophyll vine forest dominated by brown salwood (*Acacia celsa*) on very wet to wet granite foothills and uplands.	25037.1	NOC
7.12.14	Notophyll vine forest with rose gum (*Eucalyptus grandis*) emergents on cloudy wet granite and rhyolite upland ridges.	3771.0	NOC
7.12.15	Notophyll vine forest with turpentine (*Syncarpia glomulifera)* emergents on wet to moist granite uplands and highlands.	34728.0	NOC
7.12.16	Simple notophyll vine forest on cloudy wet granite and rhyolite uplands and highlands.	127955.3	NOC
7.12.19	Simple microphyll vine forest on cloudy wet granite highlands.	51569.2	NOC
7.12.20	Low microphyll vine forest on cloudy wet windswept granite highlands.	10777.2	NOC
7.1.3rs	Closed Eleocharis dulcis and/or Schoenoplectus littoralis sedgeland or mixed sedgelands and grasslands consisting of salt tolerant species, which has previously been disturbed but meets the criteria of "remnant vegetation" in the Vegetation Management Act. Occurs on poorly drained acid peats.	0.7	
7.2.3rs	Coastal beach ridge vegetation dominated by Corymbia tessellaris, C. intermedia, ± C. clarksoniana ± Melaleuca dealbata, which has previously been disturbed but meets the criteria of "remnant vegetation" in the Vegetation Management Act.	92.5	
7.2.3x2	Casuarina equisetifolia open forest to woodland with Ipomoea pes-caprae and Spinifex sericeus. Occurs on foredunes.	490.0	
7.2.4rs	7.2.4rs: Open forest/woodland mosaic (Corymbia spp., Eucalyptus pellita, Lophostemon suaveolens, Melaleuca spp., Acacia spp.). , which has previously been disturbed but meets the criteria of "remnant" in the Vegetation Management Act. Occurs on old dune ridges on a variety of soils.	53.5	
7.3.3ra	Mesophyll vine forest dominated by the feather palm Archontophoenix alexandrae, which has previously been disturbed but meets the criteria of "remnant vegetation" in the Vegetation Management Act. Occurs on the very wet lowland swamps.	21.6	
7.3.4ra	Mesophyll vine forest dominated by the fan palm Licuala ramsayi, which has previously been disturbed but meets the criteria of "remnant vegetation" in the Vegetation Management Act. Occurs of the very wet lowlands and lower foothills.	7.2	
7.3.5rs	Melaleuca quinquenervia open to closed forest, which has previously been disturbed but meets the criteria of "remnant vegetation" in the Vegetation Management Act. Occurs on very wet and wet lowlands on poorly drained peaty humic gley soils.	211.6	
7.3.6rs	Melaleuca leucadendra open forest sometimes with M. quinquenervia and/or M. dealbata which has previously been disturbed but meets the criteria of "remnant vegetation" in the Vegetation Management Act. Occurs on poorly drained lowlands.	93.5	
7.3.7rs	Vegetation complex consisting of open-forest and woodland often dominated by Eucalyptus tereticornis which has previously been disturbed but meets the criteria of "remnant vegetation" in the Vegetation Management Act. Occurs on coastal floodplains on a variety of alluvial soils.	141.6	
7.3.7x1	Melaleuca sp. aff. viridiflora forest. Occurs in seasonally inundated shallow drainage lines.	372.4	
7.3.8rs	Melaleuca viridiflora woodlands and forests which has previously been disturbed but meets the criteria of "remnant vegetation" in the Vegetation Management Act. Occurs on dry to very wet poorly drained lowlands and tablelands.	7.2	
7.3.10ra	Complex mesophyll vine forest, which has previously been disturbed but meets the criteria of "remnant vegetation" in the Vegetation Management Act. Occurs on very wet and wet lowlands on fertile riverine alluvia.	817.5	
7.3.11ra	Mesophyll rainforest with Eucalyptus pellita, Corymbia intermedia, C. tessellaris, Acacia celsa, A. cincinnata, A. mangium and A. flavescens emergents and co dominants, which has previously been disturbed but meets the criteria of "remnant vegetation" in the Vegetation Management Act. Occurs on very wet lowlands and foothills.	22.9	

RE	Description	Remnant area (ha)	VMA Status
7.3.12rs	Eucalyptus tereticornis open forest to woodland, which has previously been disturbed but meets the criteria of "remnant vegetation" in the Vegetation Management Act. Occurs on wet and very wet alluvial soils of the coastal lowlands.	71.0	
7.3.17ra	Complex mesophyll vine forest., which has previously been disturbed but meets the criteria of "remnant vegetation" in the Vegetation Management Act. Occurs on moderately sloping piedmont fans.	518.6	
7.3.18ra	Mesophyll rainforest with emergent Corymbia intermedia, Syncarpia glomulifera, Acacia polystachya and A. mangium, which has previously been disturbed but meets the criteria of "remnant vegetation" in the Vegetation Management Act. Occurs on moderately sloping piedmont fans.	158.8	
7.3.22ra	Mesophyll vine forest (gallery forest). which has previously been disturbed but meets the criteria of "remnant vegetation" in the Vegetation Management Act. Occurs on moist and dry lowlands on well drained alluvial riverine levees.	627.8	
7.8.1ra	Complex mesophyll vine forest, which has previously been disturbed but meets the criteria of "remnant vegetation" in the Vegetation Management Act. Occurs on very wet and wet lowlands and foothills.	1060.7	
7.8.2ra	Complex mesophyll vine forest of the very wet and wet cloudy uplands, which has previously been disturbed but meets the criteria of "remnant vegetation" in the Vegetation Management Act. Occurs on basaltic krasnozem and euchrozems.	86.3	
7.8.3ra	7.8.3ra: Complex notophyll vine forest, which has previously been disturbed but meets the criteria of "remnant vegetation" in the Vegetation Management Act. Occurs on moist lowlands, foothills and uplands.	129.2	
7.8.4ra	Complex notophyll vine forest which has previously been disturbed but meets the criteria of "remnant vegetation" in the Vegetation Management Act. Occurs on the cloudy wet uplands and highlands.	70.7	
7.8.7x1	Eucalyptus grandis, Corymbia intermedia, Acacia melanoxylon and Lophostemon confertus open forest and woodland, or vine forest with emergent E. grandis, Acacia melanoxylon and A. celsa (may include areas of E. resinifera) on basalt slopes. Occurs on basalt slopes.	473.4	
7.11.1ra	Mesophyll vine forest which has previously been disturbed but which meet the criteria of "remnant vegetation" in the Vegetation Management Act 1999. Occurs on very wet and wet lowlands and foothills.	3961.6	
7.11.2ra	Mesophyll vine forest dominated by the fan palm Licuala ramsayi which have previously been disturbed but which meet the criteria of "remnant vegetation" in the Vegetation Management Act 1999. Occurs on wet foothills and tablelands on humic gley metamorphic-derived soil.	14.4	
7.11.2x1	Mesophyll vine forest, with some areas including *Acacia mangium* and *Acacia aulacocarpa*, and some with fan palms (*Licuala ramsayi*). Tertiary duricrust.	108.4	
7.11.4ra	Mesophyll vine forest dominated by Acacia mangium and A. celsa, which have previously been disturbed but which meet the criteria of "remnant vegetation" in the Vegetation Management Act 1999. Occurs on very wet and wet lowlands and foothills.	1250.1	
7.11.5ra	Simple mesophyll vine forest with Eucalyptus pellita emergents which have previously been disturbed but which meet the criteria of "remnant vegetation" in the Vegetation Management Act 1999. Occurs on very wet to wet lowlands and foothills.	98.4	
7.11.6ra	Simple mesophyll vine forest with Syncarpia glomulifera emergents, which have previously been disturbed but which meet the criteria of "remnant vegetation" in the Vegetation Management Act 1999. Occurs on very wet to wet lowlands and foothills.	0.5	
7.11.7ra	Complex notophyll vine forest with Agathis robusta emergents which has previously been disturbed but meets the criteria of "remnant vegetation" in the Vegetation Management Act 1999. Most accessible areas have been extensively logged in the past.	369.8	
7.11.10ra	Notophyll rainforest, characterised by Acacia celsa, which have previously been disturbed but which meet the criteria of "remnant vegetation" in the Vegetation Management Act 1999. Occurs on very wet to wet foothills, uplands and highland ridges.	350.1	
7.11.13ra	Simple notophyll vine forest with Eucalyptus tereticornis emergents which have previously been disturbed but which meet the criteria of "remnant vegetation" in the Vegetation Management Act 1999. Occurs on moist foothills and uplands.	22.9	
7.11.18rs	Eucalyptus tereticornis woodland which has previously been disturbed but meets the criteria of "remnant vegetation" in the Vegetation Management Act 1999. Wet to moist foothills.	7.2	
7.12.1ra	Mesophyll vine forest which has previously been disturbed but meets the criteria of "remnant vegetation" in the Vegetation Management Act 1999. Occurs on the very wet and wet lowlands and foothills.	< 0.1	
7.12.5ra	Simple mesophyll rainforest with Eucalyptus pellita emergents, which have previously been disturbed but which meet the criteria of remnant vegetation in the Vegetation Management Act 1999. Occurs on very wet to wet granite lowlands and foothills.	8.8	
7.12.7ra	Complex notophyll vine forest with emergent Agathis robusta, which have previously been disturbed but which meet the criteria of "remnant vegetation" in the Vegetation Management Act 1999. Occurs on moist granite foothills and uplands.	111.1	
7.12.9ra	Notophyll/mesophyll rainforests, characterised by Acacia celsa, which have previously been disturbed but which meet the criteria of "remnant vegetation" in the Vegetation Management Act 1999. Occurs on very wet to wet granite foothills and uplands.	84.3	
7.12.16a	Simple notophyll vine forest on cloudy wet granite and rhyolite uplands and highlands	6976.0	
7.12.19ra	Simple microphyll vine-fern forest (often with Agathis atropurpurea), which have previously been disturbed but which meet the criteria of remnant vegetation in the Vegetation Management Act 1999. Occurs on cloudy wet granite highlands.	18.9	

Appendix 3. Habitat definitions used in the cassowary mapping

Essential habitat is defined as that necessary for the persistence of cassowary populations in perpetuity; those regional ecosystems where there is an accurate and verified[1] record of a cassowary and is known[2] to be preferentially used by cassowaries for breeding, feeding and general activity. That is:

- known to be used by cassowaries for breeding, either for nesting or by males with chicks with striped plumage or
- known to contain food resources that are used by cassowaries *or*
- known to be used by cassowaries, though it is unknown exactly whether this is for foraging and feeding, breeding, territorial movements, dispersal or some other aspect of its life history.

General habitat is defined as that occasionally used by cassowaries, but not considered essential for the persistence of cassowary populations in perpetuity; those regional ecosystems where there is an accurate and verified record of a cassowary, but is not known to be preferentially used as habitat. That is:

- the record is known to be a vagrant animal *or*
- the regional ecosystem is known to support cassowaries infrequently and never during times of food shortage elsewhere *or*
- there is insufficient information to determine if cassowaries use this regional ecosystem. known to be used by cassowaries, though it is unknown exactly whether this is for foraging and feeding, breeding, territorial movements, dispersal or some other aspect of its life history.

Rehabilitating habitat: non-remnant[3]regional ecosystems that consist of rehabilitating and regrowing vegetation that provide shelter and supplementary feeding and breeding resources. If allowed to return to a remnant state, these regional ecosystems would be likely to be categorised as either essential or general cassowary habitat, depending on how it satisfies the definition criteria. This includes regional ecosystems where there have been previous accurate and verified records, prior to disturbance. Rehabilitating habitat sometimes provides linking habitat that cassowaries use to traverse between regional ecosystems of essential habitat.

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[1] Accurate and verified means there is a record of cassowary from a reputable organisation or individual that could be contacted and double-checked, the record was obtained after 1980 and the record had a positional accuracy of at least 1km.

[2] Known means that the regional ecosystem has been reported in reputable research, scientific literature or via personal communication from cassowary experts as being significant habitat for cassowary for foraging, feeding, breeding or some other aspect of its life history

[3] Non-remnant means all vegetation that fails to meet the structural and/or floristic characteristics of remnant regional ecosystems in the *Vegetation Management Act 1999*. This may include regrowth, heavily thinned or logged and significantly disturbed vegetation.

From: Kutt el al 2004