

Marine and Tropical Sciences Research Facility

Market Based Instruments, Ecosystem Services and Development in Mission Beach, Far North Queensland

Background Report 2: Urbanisation and the Cassowary: Impacts and Economics



Anthea Coggan and Stuart Whitten



Australian Government
Department of the Environment,
Water, Heritage and the Arts



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Background Report 2: Urbanisation and the Cassowary: Impacts and Economics

Anthea Coggan¹ and Stuart Whitten²

¹ CSIRO Sustainable Ecosystems, St. Lucia

² CSIRO Sustainable Ecosystems, Gungahlin



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Correspondence:

Anthea Coggan
CSIRO Sustainable Ecosystems
306 Carmody Road, St. Lucia QLD 4067
Phone (07) 3214 2671
Email: Anthea.Coggan@csiro.au

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Introduction

The Southern Cassowary (*Casuarius casuarius johnsonii* or 'cassowary') is a significant keystone species to the natural environment of the Wet Tropics. The cassowary is a major and often sole disperser of seeds for over one hundred species of rainforest trees and vines (BioTropica Australia 2005). Because of the importance of the cassowary to the overall biodiversity of the Wet Tropics, research into the refining, tailoring and application of a market based instrument (MBI) to manage for environmental conservation in developing areas will use the a viable cassowary population as the objective of any instrument mix analysed.

Mission Beach is a population hotspot for the cassowary, with an estimated current population of 110 birds. The development occurring in Mission Beach (discussed in the first background report, Coggan and Whitten 2009) and the relative high density of cassowary lead us to use Mission Beach as a case study for our research.

With the maintenance of a viable cassowary population the objective of any mix of environmental conservation instruments, in this report we set out to better understand the requirements of cassowaries (habitat, etc.), the direct and indirect impacts of people on being able to achieve the viable cassowary population objective. A review of literature reveals a large quantity of information beneficial for this understanding but also that there are many information gaps. Addressing some of the information gaps will be of significant importance to the overall MBI design in later years of the research project.

Structure of this report

In the next section a brief description of the cassowary along with some key habitat requirements is provided. This is followed by an analysis of the human and urbanisation impacts on cassowaries in Mission Beach. We then analyse the undersupply of cassowaries from an economic angle through an analysis of current markets and market failures. The conditions for government intervention, conclusions for this report and implications for the next report are discussed in the concluding section.

The Cassowary as a biodiversity surrogate

The Southern Cassowary

The spectacular and flightless Southern Cassowary could be argued to be the most famous bird in the Australian Wet Tropics. Cassowaries provide a vital role to the vegetation regeneration of the Wet Tropics rainforests as they are known to be the sole disperser of the seeds of many fruiting rainforest plants (BioTropica Australia 2005).

Crude estimates put the population of the cassowary in Australia as ranging from less than 2,500 to less than 1,500 individuals (Kutt and King 2002). The highest density of cassowary population is found in the Mission Beach area with recent counts reporting 110 cassowaries in total (49 adults, 28 sub-adults, 31 chicks, two unknown) (BioTropica Australia 2005; Moore and Moore 2001). Bentrupperbäumer has calculated, by observation of individual birds, a density in the Mission Beach 'hot spot' of one bird per square kilometre (Crome and Moore 1990). Moore and Moore (2001) note that the available cassowary habitat at Mission Beach appears to be fully occupied and estimated the population density to be more like one bird per 1.29 km².

Habitat requirements

Cassowaries require a mosaic of vegetation types and a high diversity of fruiting trees to provide a year-round supply of fleshy fruits. Though the species is generally considered rainforest dependent, it utilises and traverses a large range of woodland, swamp and disturbed habitats, both as intermittent food sources, and connecting habitat between more suitable sites (Kutt and King 2002; BioTropica Australia 2005). In a transect survey of cassowary population in the Wet Tropics, Crome and Moore (1990) investigated the affect of altitude, steepness of terrain, structural damage to vegetation and existence of feral pigs to cassowaries. The results suggested that none of these factors are significant to cassowary populations. Whilst this indicates that cassowaries could use a range of habitats, Crome and Moore (1990) note that it is unlikely that populations or even individual birds can be maintained in non-rainforest habitats permanently, since the lower plant species diversity would be unlikely to supply the fruit that cassowaries need year round.

Cassowaries are territorial and solitary with home ranges calculated between five to ten square kilometres (Bentrupperbäumer 1998, Moore and Moore 2001). However, densities as high as 0.08/ha in lowland forests have also been recorded (Bentrupperbäumer 1998). Cassowaries tend to be highly nomadic in their home range. They are most comfortable in rainforest habitat but do use riparian corridors (there are records of cassowaries moving between two and three kilometres along riparian corridors between larger habitat patches); do travel across exposed landscapes (records of movement here for 0.5-1 km), and have been known to use remnant landscapes such as the Tarzali scrub. Latch (2007: 11) notes that the extent of cassowary movement is probably dependant on the broader landscape patterns such as the size of the remnants available, types of species available in the remnants, proximity of other remnants and intact habitat, presence of other birds, food sources and fruiting phenology.

Cassowary habitat has been identified and mapped in the Wet Tropics by the Environmental Protection Agency (EPA) / Queensland Parks and Wildlife Service (QPWS) and is based on the Regional Ecosystem (RE) mapping developed by the EPA. Regional ecosystem mapping also describes the conservation status of the vegetation (*endangered* dominant, *endangered* sub dominant, *of concern* dominant, *of concern* sub dominant and *not of concern*) (Figure 1). In the mapping, essential habitat categories are layered over the mapping of conservation status. While three categories of habitat have been defined, only the category of 'essential

habitat¹ is afforded protection under the *Vegetation Management Act 1999*² (VMA). Other mapped habitat includes:

- 'General habitat', while sub-optimal habitat for cassowary survival, is important in providing linking habitat that cassowaries use to traverse between areas of essential habitat; and
- 'Rehabilitating habitat', which identifies areas of non-remnant vegetation not mapped under RE mapping but important in the landscape for cassowaries as potential areas for restoration or rehabilitation and/or for their corridor value (Latch 2007).

Essential habitat under the RE mapping is determined by, but not limited to, a number of criteria (QDNRW 2006):

- Vegetation: The species or types of vegetation that the species is associated with;
- Regional Ecosystem: the regional ecosystem(s) that the species is most commonly associated with;
- Land zone: This is the underlying geology associated with a regional ecosystem;
- Altitude: The range of altitudes at which the species is found;
- Soils: The type of soils on which a species is most commonly found; and
- Position in the landscape: A more precise description of the landscape features the species is commonly associated with. Such as creek bank, levees, lower slopes, hillsides and ridges.

Mapping of essential habitat for cassowaries for the Mission Beach area is presented as Figure 2. It is important to note that while the VMA does provide some protection for essential habitat, there are many exemptions within the VMA that allows essential habitat to be cleared in the urban footprint (without offsets) or outside of the urban footprint with offsets. Exemptions are also applicable where the vegetation is categorised as 'not of concern', which is the case with a large proportion of Mission Beach essential cassowary habitat. The exemptions and the implications of these are discussed in detail in Coggan *et al.* (in press).

The final cassowary habitat requirement identified in the literature is the location of vegetation to water sources. Cassowaries drink a significant amount of water (drinking on average 2.3 times per hour), so riparian habitat tends to be favoured by birds (BioTropica Australia 2005).

In 2001, Moore and Moore conducted an extensive search and analysis of the cassowary population of Mission Beach. They concluded that many earlier categories of cassowary 'zones' were based on high cassowary visibility rather than contextual knowledge of how the cassowaries used the habitat (e.g. what habitat was essential to functions such as feed, breed and roost, etc.). Moore and Moore (2001: 80) state that critical Mission Beach cassowary habitat was that contained in a polygon "extending from Double Mountain in the north, south to the North Hull and Hill Rivers (South of the Tully-Mission Beach Road) and west to include the western arm of the Walter Hill Range and the Carmoo Creek National Park" (this information was not found in mapped form).

¹ Essential habitat is what is considered to be necessary for the persistence of cassowary populations in perpetuity.

² The cassowary conservation plan is aimed at conserving this essential habitat.

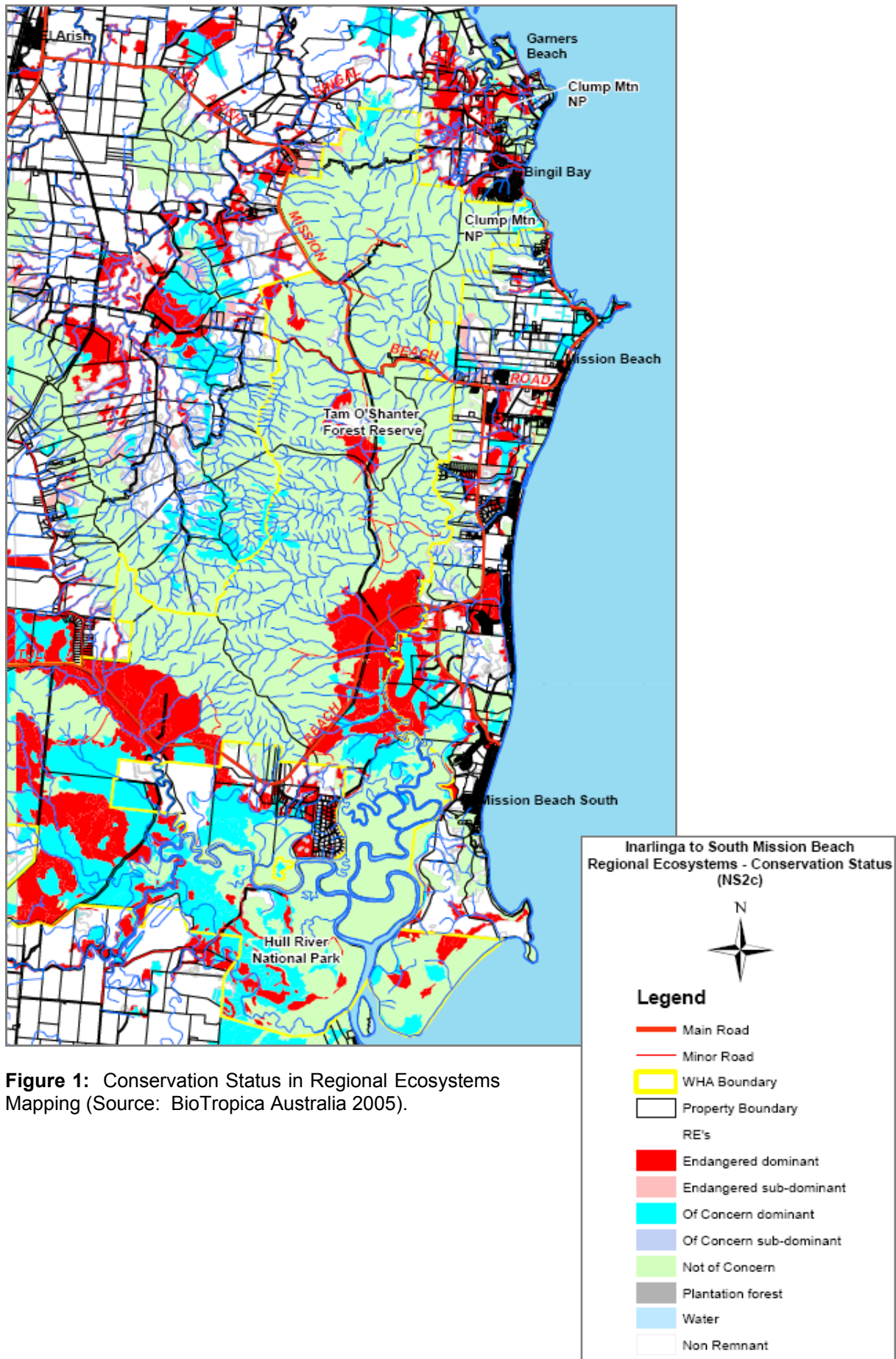


Figure 1: Conservation Status in Regional Ecosystems Mapping (Source: BioTropica Australia 2005).

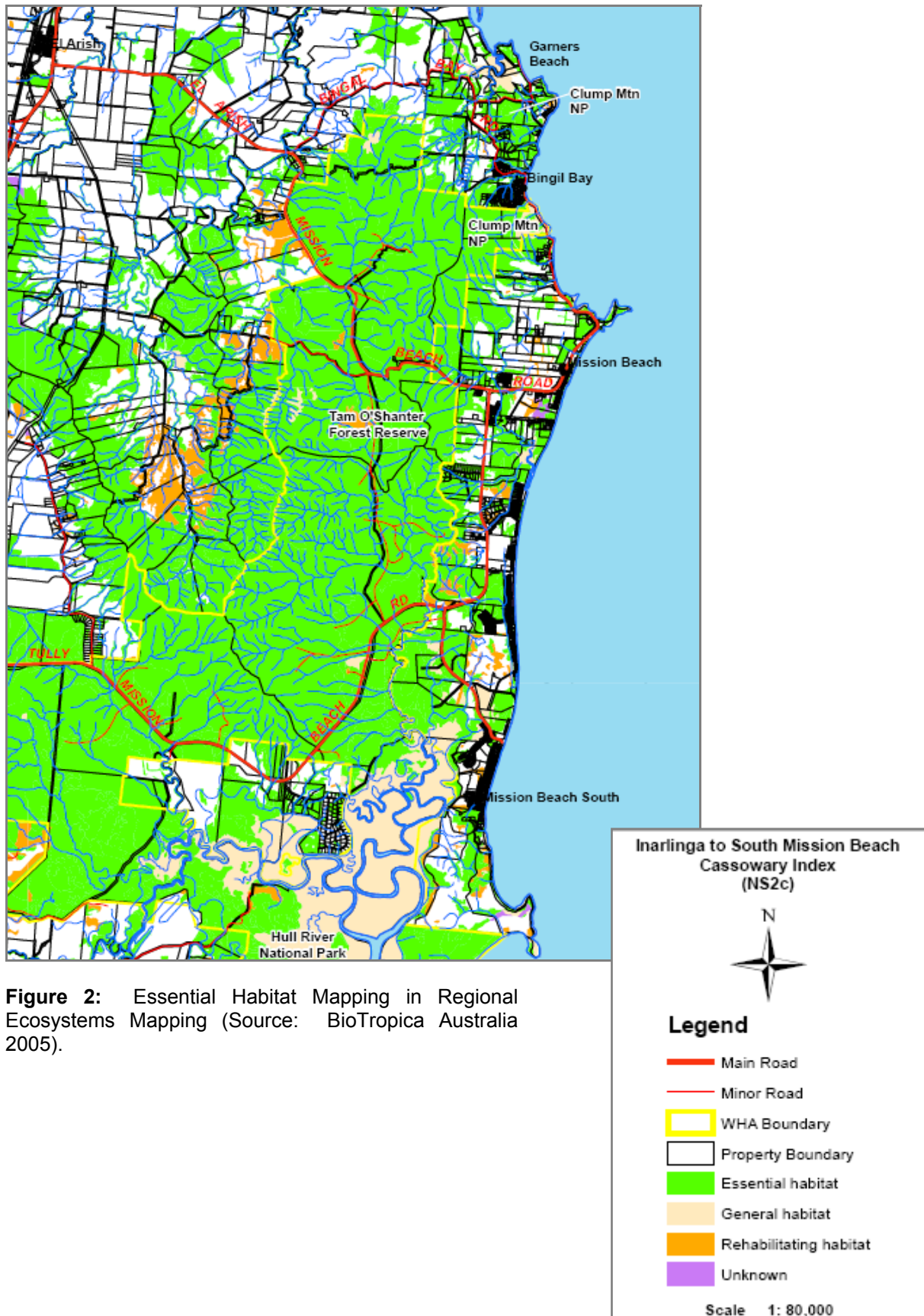


Figure 2: Essential Habitat Mapping in Regional Ecosystems Mapping (Source: BioTropica Australia 2005).

What is happening to the cassowary?

People and the cassowary

Cassowaries are long-lived, slow to reproduce animals with lengthy periods of parental care and low juvenile survival. Each death of an adult bird has a disproportionately large impact on population reproductive fitness and viability (Latch 2007). Latch (2007) in the most recent Cassowary Recovery Plan identifies eight main threats to the cassowary population broadly:

1. Habitat loss from clearing;
2. Habitat fragmentation;
3. Habitat degradation;
4. Roads and traffic;
5. Dog attacks;
6. Hand feeding;
7. Diseases; and
8. Natural catastrophes.

Threats 1-6 can be directly related to humans and the encroachment of people on the cassowary through urbanisation of the Wet Tropics. It could be said that cassowaries are more vulnerable to Threats 7 and 8 due to exposure to humans.

The significance of the threats varies across the landscape, for example road mortality is a major threat where urban / peri-urban development encroaches on cassowary habitat. In addition, the level of the threat also varies depending on the age of the population. For example, sub-adults and chicks are most vulnerable to dog attacks. Dispersing sub-adults may be particularly vulnerable to habitat fragmentation as they have to travel further to access food and new habitat increasing their risk to road mortality (Latch 2007).

The impacts of humans on cassowaries are discussed in more details in the remainder of this section.

Habitat destructions and fragmentation

Habitat loss

Latch (2007) details the extent of habitat loss in the Wet Tropics, highlighting that habitat loss is particularly severe in the lowlands. By 1983, 57% of lowland rainforest had been cleared with the remainder being highly fragmented. By 1997, 81% of the lowland native vegetation had been cleared (Latch 2007, BioTropica Australia 2005). The lowland forest is essential cassowary habitat (BioTropica Australia 2005). Moore (2001: 72) notes that land clearing accounted for eighteen percent of habitat loss in Mission Beach over the period 1992 to 1998. Continued clearing will significantly influence some critical habitat linkages in the area and result in isolated cassowary populations (Moore 2001: 72).

Habitat fragmentation

In the BioTropica Australia report (2005: 10) it is noted that the non random pattern of deforestation in the Wet Tropics has seen remaining cassowary habitat confined to steep slopes and poorly drained sites unsuitable for agriculture and human settlement. This has created two north-south aligned forest massifs:

The coastal north-south linkage “follows the lowlands north of Cardwell, traverses the Mission Beach – Kurrimine areas before entering the Moresby Range, Graham Range, Seymour and Malbon Thompson Ranges” (BioTropica Australia 2005: 10).

The inland linkage “follows the Cardwell Ranges north through the Walter Hill Ranges, the catchments of the north and south of Johnstone River and the Bartle Frere / Bellenden Ker massif”. The two north-south linkages are generally continuous for their entire length, only broken occasionally by roads and natural barriers such as rivers.

The north-south linkages are separated by an intensively developed coastal plain with a land use type dominated by sugar cane production (BioTropica Australia 2005: 10). The scale of clearing between the coastal and inland zone has resulted in two main cassowary populations – the only links between the two are “riparian fragments along streams and rivers that happen to be running east-west” (BioTropica Australia 2005: 11).

There are portions of the north-south linkages that are also highly fragmented. BioTropica Australia in their 2005 cassowary habitat linkages report split Mission Beach into two north-south linkages – **Inarlinga to South Mission Beach** and **South Mission Beach to Cardwell**.

BioTropica Australia 2005 note that the Inarlinga to South Mission Beach section contains the high density Mission Beach cassowary population and is the most heavily fragmented section of the coastal north-south linkage (Figures 1 and 2).

The South Mission Beach to Cardwell north south linkage of the Mission Beach habitat is virtually intact. The northern extremity of this sub unit of habitat is considered to be significant source area for the cassowary population. It is believed that up to fifty percent of chicks born in the Mission Beach precinct originate here. Entry and exit linkage to this patch is significant to the viability of the cassowary population. BioTropica Australia (2005: 18, 19) have identified property lots where vegetation is critical to maintaining linkages as well as locations of other properties where vegetation protection or restoration efforts would be advantageous.

It is noted by DEH (2006) that a cassowary population viability study by Moore (2003) indicated that based on available data, fragmentation is THE MOST SERIOUS threat facing the Mission Beach cassowary population. In Moore’s report it is claimed that the isolated population would see a reduction in genetic diversity such that the eventual extinction of the population is likely. Coggan *et al.* (in press) assesses the institutions and structures in place to stop this vegetation fragmentation. It is found that there are many exemptions to clearing legislation especially in critical cassowary habitat. With this, habitat fragmentation is likely to get worse not better.

Habitat degradation

Selective logging, weed invasion and disturbance to the rainforest by changed fire regimes all affect the quality of cassowary habitat (Latch 2007). This occurs either through changing the canopy structure, degrading breeding sites or reducing food sources. The quantity of quality habitat is also reduced as more people live in the area increasing the area of the habitat that is considered to be the edge and be affected by ‘edge effects’ (increased disturbance, changed light, increased weed impacts, dogs and human disturbance).

Some concluding comments on habitat and cassowaries

From the literature, it can be said that a viable cassowary population is affected by the extent and location of the habitat (fragmentation) as well as the quality of this habitat. This indicates that there are three levels of habitat actions that could potentially be addressed by a MBI:

1. **Non substitutable actions such as the establishment of core linkages:** East-west linkages between north-south linkages; and the maintenance and connection to the northern extremity of the South Mission Beach to Cardwell sub unit of habitat. These are non substitutable because they have to occur in a particular place in the landscape to be effective, they can not be substituted with another action and still achieve the same result.
2. **Partially substitutable actions:** These would be the actions that create buffers to existing linkages or create secondary linkages. These actions are partially substitutable because there is a bit more flexibility with where the linkages can occur to gain the same outcome compared with the core linkages, but the actions and locations are still constrained.
3. **Substitutable actions:** Some actions that could be conducted by landholders to improve the habitat of cassowaries are substitutable (e.g. habitat extensions, vegetation controlled burning, etc.) to a degree.

The types of actions and the design of the instrument to bring about these actions such a viable cassowary population results will be one of the research focuses of this project into the future.

Traffic impacts

Not all human impacts on cassowaries are the same throughout the wet tropics. The nature of the impact depends on the level of interaction between the cassowary and the human population. Road impacts are one example of an unevenly distributed human and cassowary interaction and one that is significant in the Mission Beach area.

Of the 125 cassowary deaths recorded in Queensland from 1986 to 2004, 61 were from motor vehicle strike. Of all the cassowary deaths recorded for the same period, 63% (79 deaths) were recorded in the Mission Beach area. The majority of these deaths were from motor vehicle strikes (62%) and dog attacks (18%) (Moore 2007). The high road mortality rate has a number of potential causes:

- Degraded and fragmented habitat (from urbanisation but also from natural events such as cyclones). When habitat is degraded or fragmented, cassowaries are forced to widen their territory in order to gather enough food. As distances travelled by the birds increases, the probability of crossing a road also increases.
- An increase in visitor and resident trips using the roads.
- Birds are attracted to roadsides where they have been fed by people in the past (Crome and Moore 1990).

The level of impact is also dependent on a number of road related factors. For example, a road of greater width tends to be associated with a higher number of road kills. This is because it takes longer for an animal to cross a wider road and wider roads tend to accommodate faster moving vehicles. The nature/characteristics of the road users also has bearing on the cassowary outcomes of there road use. Cassowaries are most active in dawn, dusk and in the evening (Moore and Moore 1998). Therefore a road that is used most frequently at this time (e.g. roads that carry a lot of commuters) may have a greater cassowary impact than a road that has an evenly distributed level of use (this may also indicate that residents and not visitors will have the greatest road related impact on the cassowary).

There have been several studies attempting to better understand traffic impacts on cassowaries. Moore and Moore (2001: 75) identified the number of crossings on key Mission

Beach roads as well as the demographics of the birds using these crossings. Moore and Moore (2001) note that on the El Arish-Mission Beach Road between Bingil Bay Road and the junction with Tully Mission Beach Road (8.4kms) (A and B in Figure 3), twelve crossings were identified. It was estimated that this would service sixteen adult birds, representing 33% of the adult cassowary population of Mission Beach.

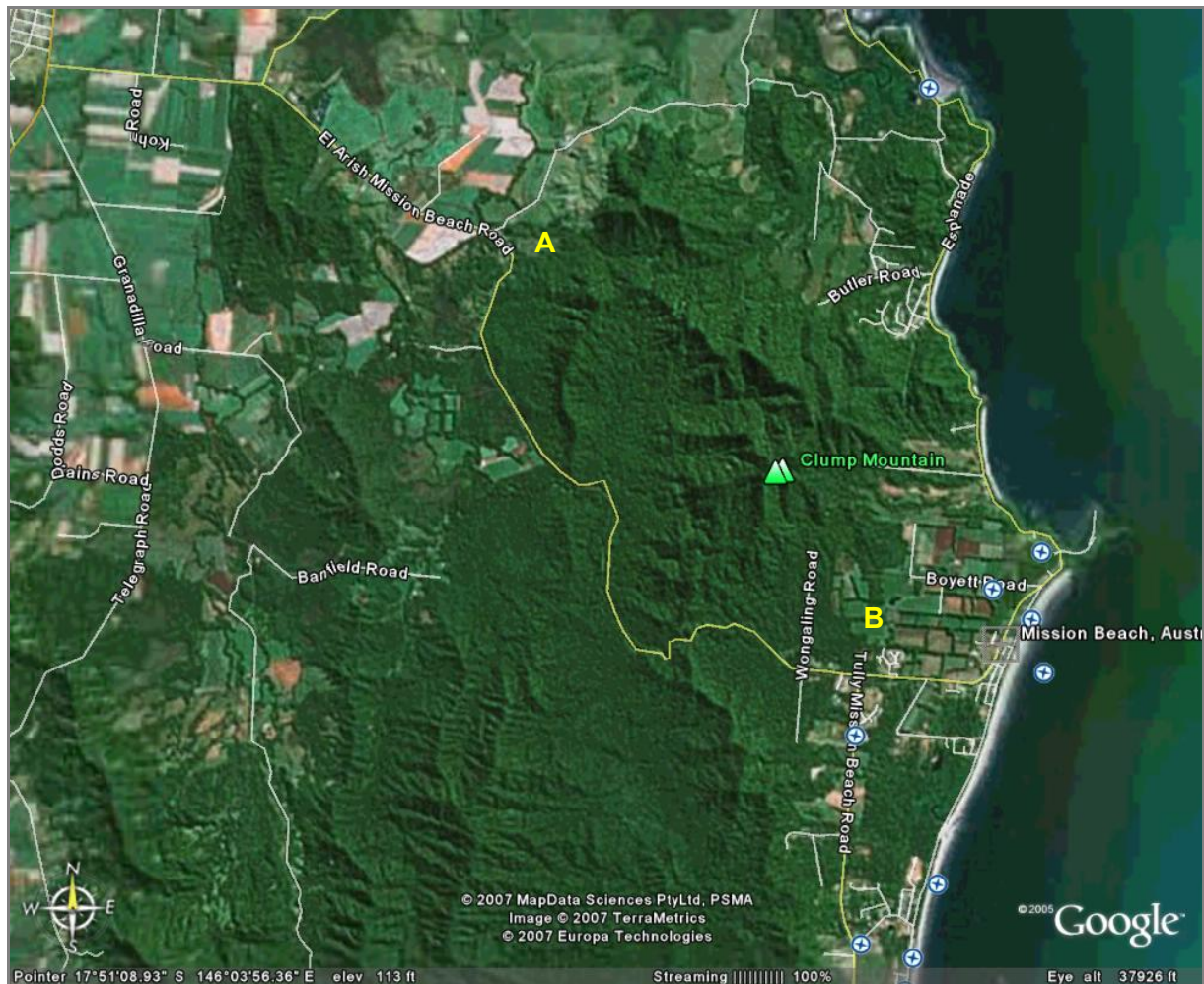


Figure 3: El Arish – Mission Beach Road, between Bingil Bay and Tully – Mission Beach Road (Source: Google™ Earth 2006).

On the Tully – Mission Beach Road, ten crossing points were identified between the El Arish and Tully – Mission Beach roads and Sugar Cane Creek (15.2kms) (road junctions noted as C and D in Figure 4), it is estimated that seventeen adult cassowaries made use of these crossing points, representing 35% of the adult cassowary population of Mission Beach.

The El Arish – Mission Beach Road and the Tully – Mission Beach Road are both located in high priority cassowary corridor areas (Moore and Moore 1998: 12). In fact the Johnstone Shire Council specifically identifies the El Arish – Mission Beach Road in this light (Figure 5). Management of this Priority 1 corridor is discussed in more detail in Coggan *et al.* (in press), exploring institutional arrangements for the management of development and the cassowary in Mission Beach.

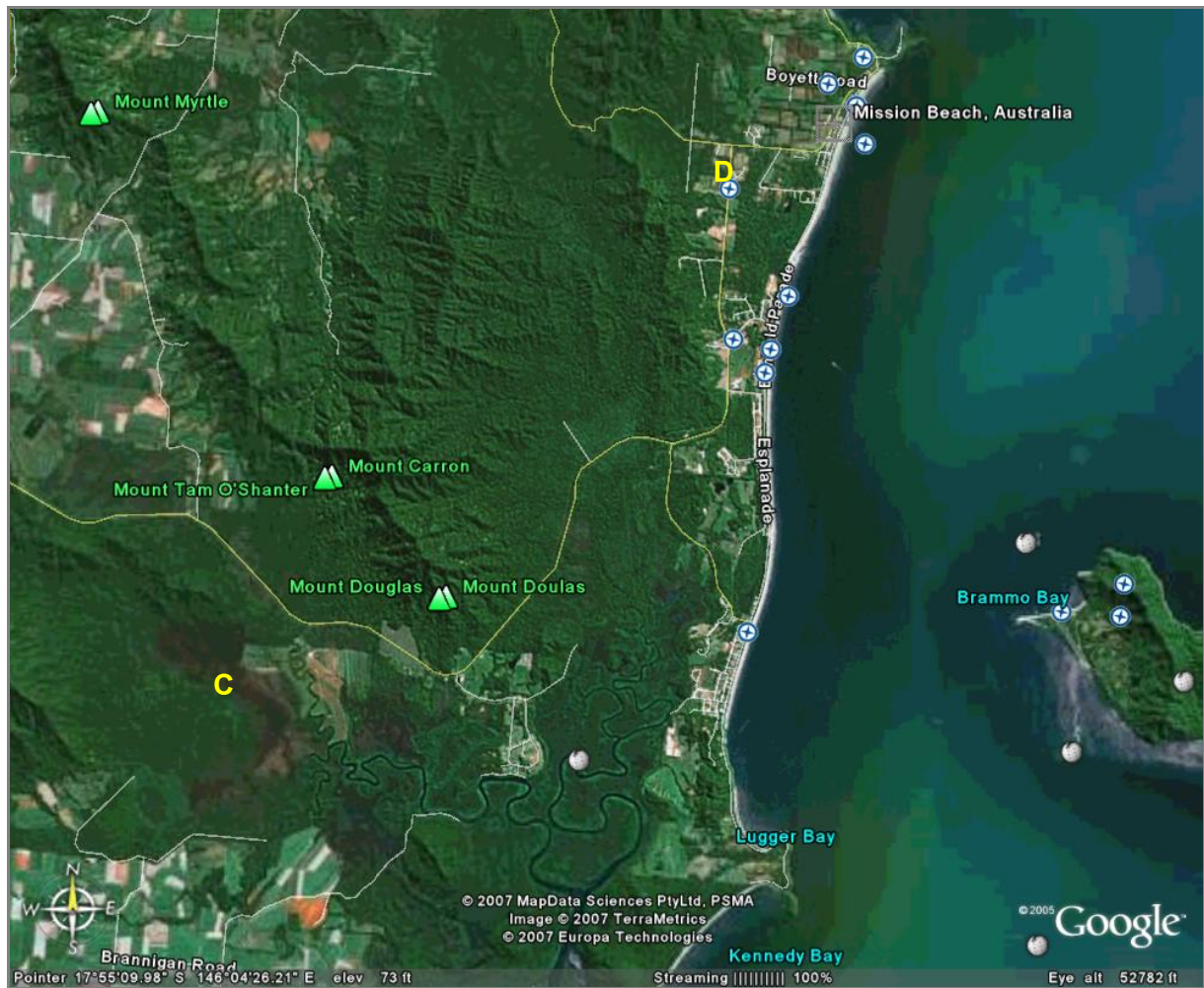


Figure 4: Tully – Mission Beach Road between El Arish and Sugar Cane Creek (Source: Google™ Earth 2006).

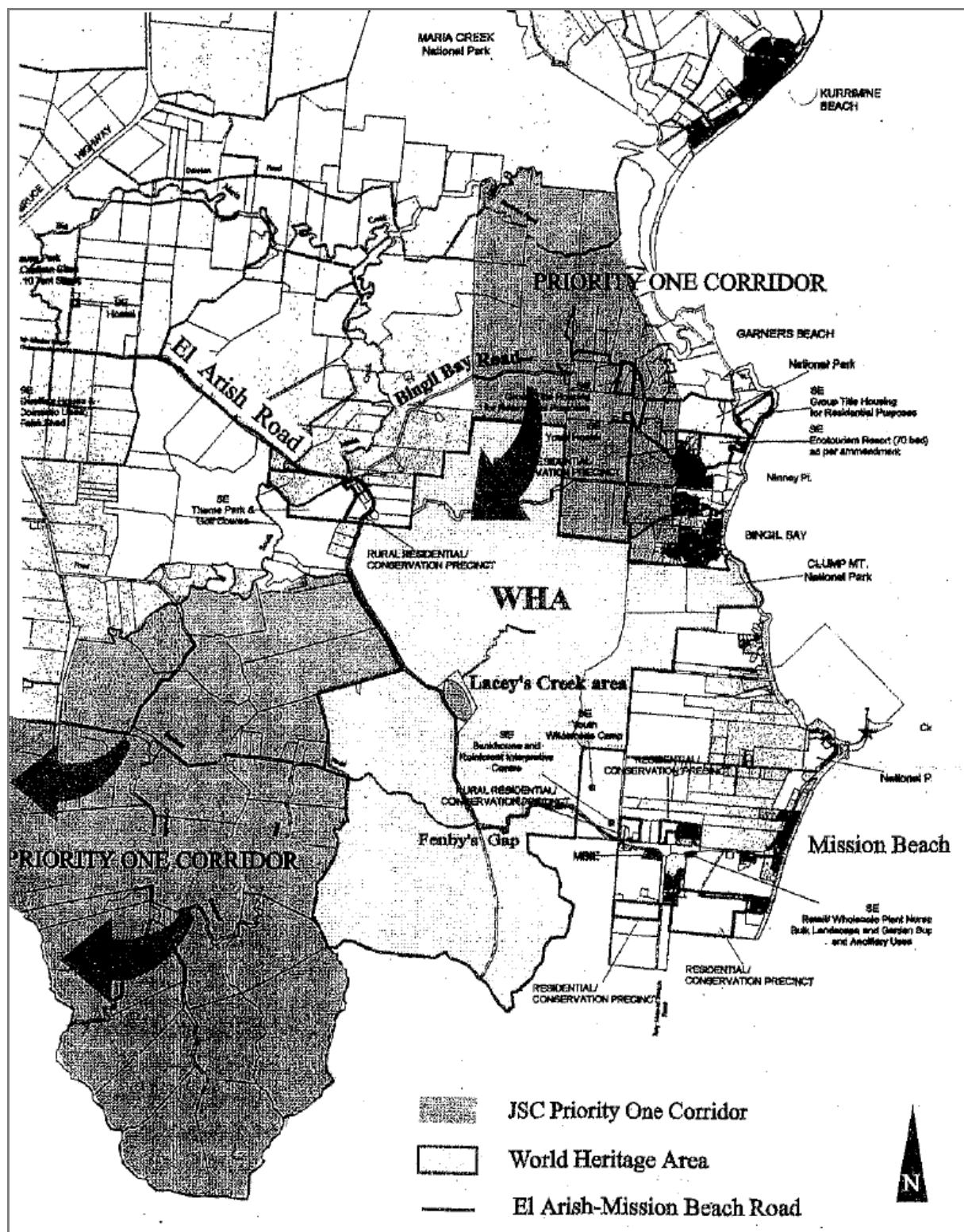


Figure 5: Johnstone Shire Council cassowary priority habitat and main roads (Source: Moore and Moore 1998).

There are a number of options that can be used separately or in combination for safe guarding cassowary crossing points (Moore and Moore 1998), the options as well as some potential issues associated with these options are listed in Table 1.

Table 1: Cassowary crossing management options (adapted from Moore and Moore 1998).

Option (1)	Description /purpose	Potential issues
Cassowary warning sign	Especially at the start and end of cassowary crossing hot spots such as Tom O'Shanter National Park	Visual pollution; and Could encourage drivers to be less wary when not in the direct zone of the signs
Rumple strips and audible road etching	Alert drivers to the change in road conditions	
Reduced speed limits (<70km/hr)	This is significant if the road is widened and the verge is reduced. A smaller verge gives motorists less time to see and stop for cassowaries	
Road surface made of noise emitting material	Alert drivers to presence of cassowaries	
Painting on the road at known crossing points	Alert drivers to presence of cassowaries	Risk that motorists will speed up away from these crossing points and not all cassowaries are going to cross at the designated crossing
Clearing of vegetation on some verges	Improved visibility on approaches to known crossings (around corners and on crests and dips)	Potential spill over dis-benefit to other animals that cross the road using the canopy (possums, etc.)
Modify existing culverts (vegetate to funnel fauna into the pipe, dry path through culvert, pipe near culvert)	Safe under-road crossing	Current culverts are not necessarily where crossings take place. Efficacy of modifications is unknown.
Build new culverts	Safe under-road crossing	Both roads exist on flat topography with consistent vegetation blocks – there is very little incentive for cassowaries to use culverts
Fence off the crossing point	Only when bird is at extreme risk	Major barrier to birds' patterns and lifestyles.
Remove attractors at the road side	Remove fruiting trees close to the road side	Cannot remove some fruit farms that are visited opportunistically by cassowary.

A more indirect road cassowary management option is in the investment of hand raising chicks left orphaned by road impacts. Quadrio (2006) notes that initial results from some very recent research indicates that chicks can be successfully hand raised and re-released.

While there are a few clear options for reducing the potential of cassowaries being impacted by vehicles, Jay Quadrio (pers. comm. Queensland Department of Main Roads) highlights that no clear relationship can be made between increasing traffic and increasing impacts on the cassowary from this traffic. This is because cassowary road avoidance behaviour changes. For example, at low traffic numbers, cassowaries stand around on the road and can be killed just as frequently as when traffic numbers are higher. Other factors that

complicate any linear cause and effect relationship between roads and traffic and cassowaries include:

- Human/cassowary interaction behaviours are continually changing. More people fed cassowaries in the early 1990s, which enticed them onto the road, leading to more deaths. Cassowaries are now attracted to road edges by fruiting weeds like raspberry.
- Cassowary movement is affected by other natural events. Tropical Cyclone *Larry*, which hit the Innisfail region in March 2006, significantly reduced food sources, resulting in wider foraging habits and an increase in cassowary-human interactions, which can be aggressive. Territory altercations can see cassowaries cross roads at speed, giving a driver no time to stop.
- The forest destruction from Cyclone *Larry* also resulted in the covering of many cassowary paths, those with roads in their territory tended to use roads as paths, increasing the chance of them being struck by a vehicle.

Some concluding thoughts on cassowaries and roads

While roads exist in cassowary habitat, cassowaries will continue to cross roads. One significant indirect impact of humans on cassowaries in Mission Beach is through human use of roads. While not all of the information is available to be able to make a conclusive cause and effect relationship between humans and roads, we do have parts of the picture. We also have parts of the picture on actions that could reduce the impact of people.

We know:

- The locations of main roads into and out of Mission Beach;
- Where cassowaries frequently cross these main roads;
- The number of vehicles using the roads;
- How many cassowaries have been killed to date and per year (however we can't make a linear relationship between the number of cars and cassowary deaths because of the changing nature of cassowary-road interactions);
- Which parts of the roads have had improvements made, and which parts still require actions for improvement with respect to cassowaries (e.g. signage, speed limits, revegetation and management of vegetation near to roads, either more or less or the management of the type of vegetation);
- There is limited opportunity to improve current or construct new culverts for alternative crossing points (would be very hard to train cassowaries to use them);
- Cassowaries mainly cross the road at dawn and dusk and in the evening and are stunned by car headlights. From this we can assume that more residents working outside of Mission Beach will have a greater road related impact on cassowaries than visitors. This is because residents are more likely to be using the road at high cassowary movement time. Residents are also likely to become accustomed to warnings, drive faster on familiar roads and be less wary of cassowaries.
- Cassowaries will visit roads more frequently if there are food attractors close to the road.
- An increase in road width is likely to result in increases in birds affected by vehicles, due to the fact that a wider road means a larger distance to cross (increasing the chance of vehicle strike); wider roads facilitate faster traffic (again, increasing the change of vehicle strike); and a wider road with no change in verge will reduce driver visibility, increasing the chance of vehicle strike.
- That once the population of Mission Beach reaches a number close to 20,000, the current road will be widened to four lanes.

We also know that cassowaries change their behavioural patterns in response to a number of environmental conditions. Therefore no clear cause and effect relationship between cassowaries and roads can be made. Further, it is not known what the success of any of the mitigating factors might be in reducing cassowary road impacts. Therefore we don't know what actions might be preferred over others.

From this we can conclude that we may be able to include the road related impacts of development on the cassowary as a part of a Market Based Instrument. However, more consideration is needed on how this can be done and how uncertainty can be included in this exchange. The subtle differences in the Market Based Instrument rules and inclusions and how these affect the outcome will be investigated in future years of this research.

Dogs and pigs

Dog attacks on cassowaries cause injury and death and also upset important functions such as breeding and movement behaviour. Latch (2007) notes that dog attacks are second to vehicle strike in cause of cassowary death. Six cassowaries are known to have been killed by dogs in the Mission Beach area between 1995 and 2002. Twenty cassowary deaths from dog attacks were recorded in the whole Wet Tropics between 1986 and 2004 – fourteen of these were in the Mission Beach area. Sub-adults and chicks are extremely vulnerable to dog attacks (five of the six deaths involved sub-adults and chicks). Dog attacks have a significant impact on population recruitment.

Pigs are known to destroy cassowary nests (Crome and Moore 1990) and eat their eggs (Latch 2007). Being ground-feeding omnivores, pigs are also important potential habitat competitors of cassowaries. The wallowing activities of pigs may impact on water sources which could then affect cassowary populations.

Some concluding comments on the impacts of humans on cassowaries

People have a significant direct and indirect and ongoing impact on cassowaries. This impact occurs through the direct removal of their habitat as well as human activities encroaching on the quality of the remaining cassowary habitat or impacting on their day to day activities such as movement within territory (and being struck by vehicles). Current legislation does very little to stop the clearing of cassowary habitat for development, and to stop the indirect impacts of people living within cassowary habitat. This is discussed in detail in Coggan *et al.* (in press). The analysis of the habitat requirements for cassowaries as well as the indirect impacts of people does give some insight into where an offset market based instrument may occur. This analysis also gives some insight into how an offset might be structured. For example, the difficulty in being able to measure the extent of mitigation of road related impacts indicates that this type of offset perhaps should be coupled with actions that are more measured with greater ease and to greater certainty.

Why does urbanisation impact so significantly on the cassowary? The economics of cassowaries

The economic value of the cassowary

All goods have a value. For goods that are traded in a market place, such as bread, milk, cars, etc. the value is easily ascertained as it is reflected by the prices that people are willing to pay or accept in exchange for these goods. The value of a good that is not exchanged in a market place is more difficult to define.

In environmental economics the value of a non-exchanged good can be considered in terms of the direct and indirect use and non-use values of that good (Figure 6 describes this for biodiversity in general) (Stoneham *et al.* 2000: 7; OECD 1999: 28-30; Nunes and van den Bergh 2001: 205-207).

A direct use value is one where the resource can be directly consumed, traded or used in a commercial activity. Direct use means that the value of good can be privately appropriated (OECD 1999: 29). Cassowaries cannot be privately traded or consumed, however benefits from cassowaries (both through seeing them and their function in the landscape) can be privately appropriated through activities such as nature-based tourism. Of course people also visit the area for other reasons (beaches, etc.), and because of this the tourist dollar cannot be wholly used as a surrogate value for the cassowary.

The cassowary also has many indirect use values. These are the values derived from all the functions of a cassowary that provide direct well being to humans but which can not be privately appropriated (OECD 1999: 29). The fact that the cassowary is a keystone species for the health of the rainforest indicates that the indirect use values from the cassowary are high. Some indirect benefits from the cassowary include native vegetation regeneration which results in soil conservation and flood control benefits. When the potential derived value of a good is unknown but considered to be substantial this is an option or quasi option use value (OECD 1999: 30). It can be said then that the public has a high option or quasi option value for the cassowary.

Benefits derived from non-uses of a good are commonly categorised as existence and bequest values. Existence values derive from the knowledge that the good exists and is independent of any known current or future use of the good. Bequest values derive from the current generation's knowledge that the good will be available for future generations' direct or indirect use (Stoneham *et al.* 2000: 9).

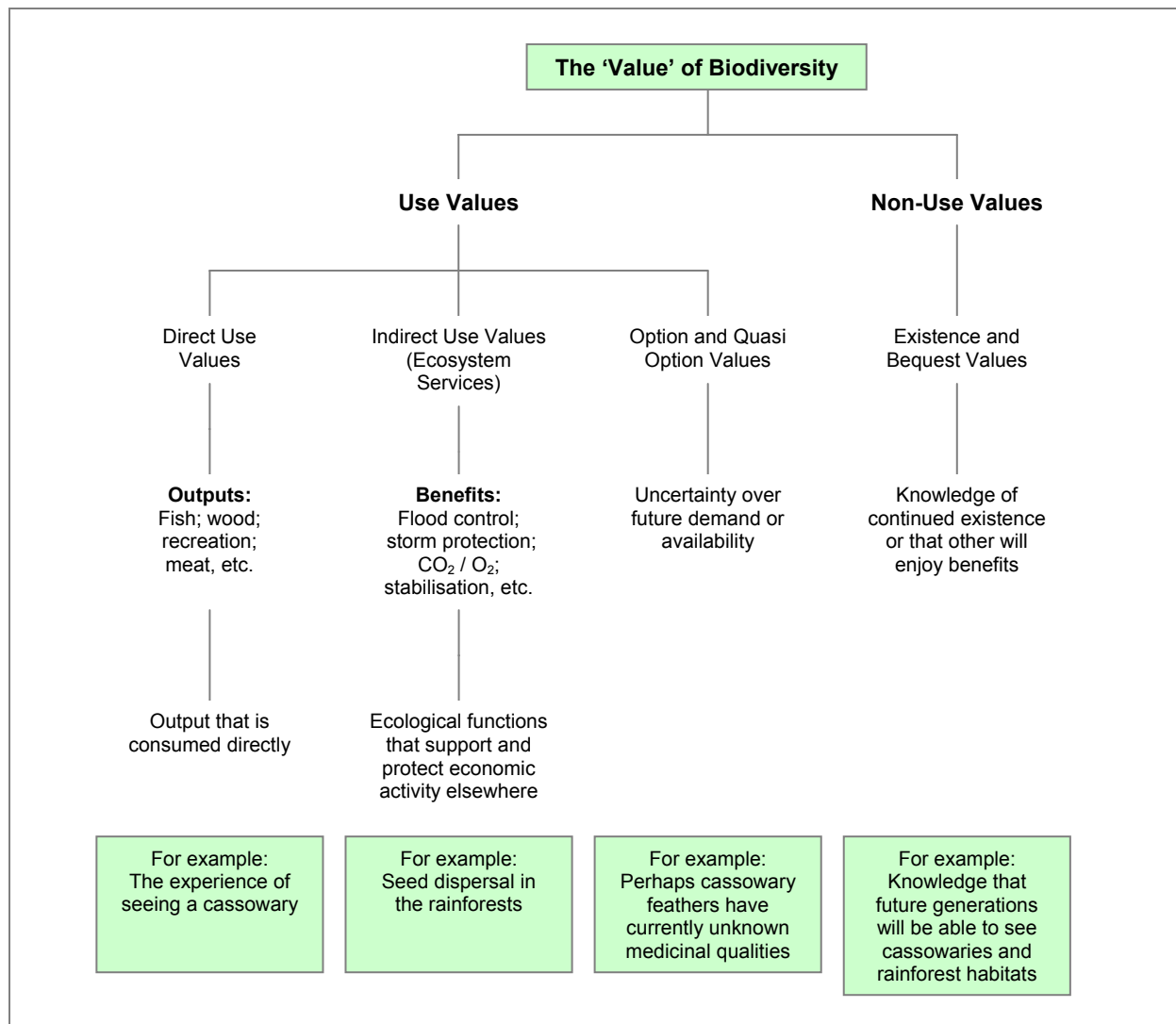


Figure 6: Use and non-use values of biodiversity (adopted from OECD 1999: 30).

Why is the cassowary under-supplied?

If maintaining a minimum viable population of cassowary has high direct and indirect use and non use values, then why is the value of cassowaries not taken into account in the development process? To begin to answer this question, we need to analyse why developers make decisions the way they do.

The land market and conflicting uses for human and cassowary habitat

The land that provides habitat for cassowaries can also be used for other activities such as the production of food and fibre or the housing of residents and tourists. Land scarcity means that there will always be trade-offs between alternative outputs for this land. Production decisions are made by the owners of the land according to the institutions in which they operate and the resulting incentives that they face (Wills 1997). In Australia, the dominant institution that drives most land allocation decisions is the market, supplemented by centrally planned controls. Markets signal information through prices, and operators in the market respond with the objective to maximise individual returns.

One of the fundamental bodies of theory in modern economics deals with the concept of a perfectly competitive economy or the market. Large numbers of profit maximising firms and utility maximising consumers, and, full information and low transaction costs of exchange results in the self motivated action by operators in the market leading to patterns of production and consumption that are efficient (Weimer and Vining 1992; Kasper 1998). Efficient production is where it is not possible to make one person better off without making another worse off. This outcome is generally referred to as Pareto efficient (Weimer and Vining 1992; Grafton *et al.* 2004; ABARE 2001). An efficient market in this sense would find the optimal land allocation amongst residential, agricultural and cassowary habitat.

There are, however, a number of characteristics that are essential for the functioning of the perfectly efficient market. These include fully defined and allocated property rights, full and low cost information and a means for exchanging the goods.

Property rights are the institutions that define resource access and ownership. Property rights provide a bundle of rights to possess, use, benefit from and dispose of valuable and scarce assets that the state will agree to protect (Kasper 1998; Bromley 1991). To be effective, however, property rights must be excludible, divisible (in both scope and space) and transferable. Whitten and Bennett (2005) describe these attributes as follows:

- **Excludability** allows the owner to exclude others from consuming outputs. This feature relies on the practicality of identifying and stopping potential consumers. No one owns cassowaries or can prevent others from enjoying them.
- **Divisibility** is the ability to separate the bundle of property rights in space and scope. Divisibility allows property right owners to manage the sub components of a resource separately or to divide up and sell separate pieces of the resource. Property rights to land are divisible and often result in the subdivision of land. Cassowary 'property rights' are less divisible and the overall value tends to be compromised by the divisibility of land property rights.
- **Transferability** grants the ability to sell off parts of the property right to others (similar cassowary issues to the above).

Another characteristic for a perfect market is full information about the goods' attributes being available to buyers and sellers (Weimer and Vining 1992). The full information criterion requires that producers and consumers know the relevant product information such as quantity, quality, time and location of supply, price and so on. Information failures generally result from high transaction costs. That is, the information exists, or can be obtained, but only at a cost. For a complex good like cassowary habitat, it is more likely that important information does not exist or is extremely costly for individual landholders to collect (Young *et al.* 1996).

Other features which aid in facilitating efficient markets are sufficient numbers of buyers and sellers to ensure competition and an agreed place and method of exchange. A robust and replicable measure of the quantity and quality of goods on offer in the market is also critical to efficient exchange.

Clear property rights, price signals and exchange systems exist for some land uses, such as housing, but not for others. As a result, land is bought and sold for private benefit with the land value associated primarily with the lands housing development potential. While the market works well for the exchange of land for housing, the current market does not fully consider the extent or quality of cassowary habitat on the land price. As a result, private landholders do not make a conscious effort to supply this good in general and the exchange of land often occurs to the detriment of cassowary habitat.

The land market and spill-over impact on cassowaries

In addition to the current market failing to signal the value of cassowary habitat to developers, the current market also does not signal the indirect or spill over effects of development on cassowaries.

As discussed in previous sections of this report, development will have an initial and direct impact on cassowaries (through the removal of habitat) as well as a cumulative and ongoing impact through the facilitation of more people in close vicinity to the cassowary. In the literature it is continually highlighted that the cumulative spill over impacts of development are significant.

The direct and spill over effects of development on cassowaries are illustrated in Figure 7.

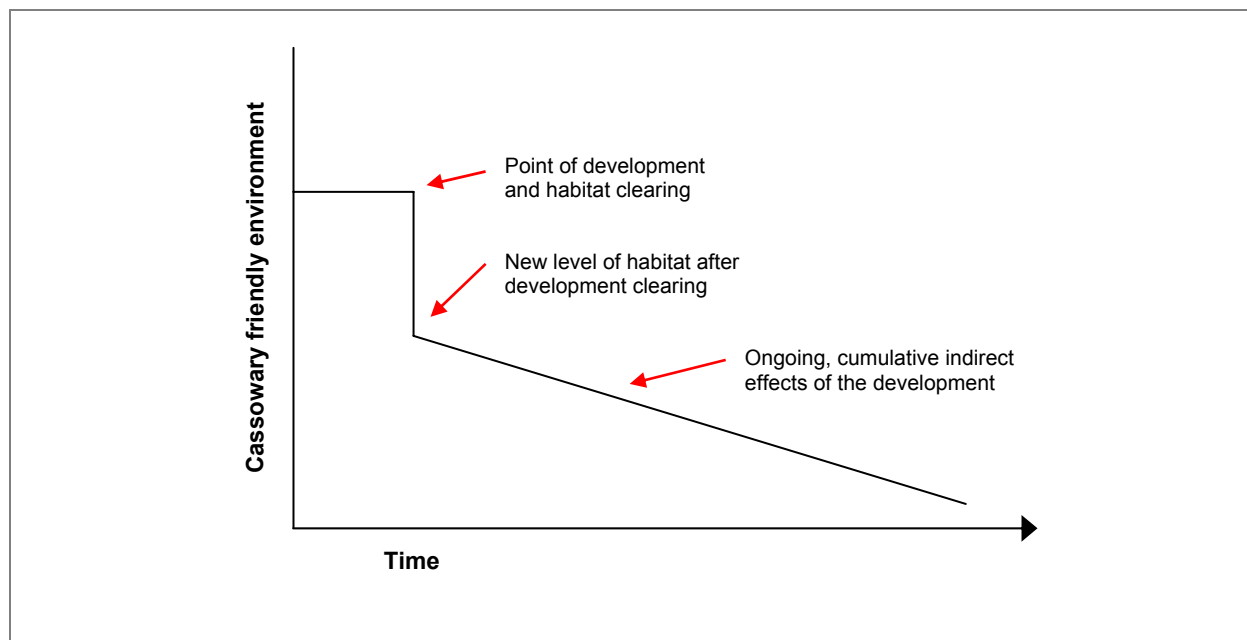


Figure 7: Hypothetical direct and indirect development effects on the cassowary.

Market failure for the cassowary

When the market fails to provide a good to a level which is socially optimal, market failure is said to have occurred. There are many reasons why a market might fail to produce the socially optimal supply of a good, often more than one cause will present. A summary of common market failures and what these mean for cassowaries is presented in Table 2.

The critical outcome of the public good and externality market failures is the lack of information and incentive exchange between those that benefit from actions to conserve cassowaries and those that can physically take action. The effects of this on the cassowary are magnified because at the same time the market works well to exchange information on the development potential of the land. With this occurring, the land owners will respond by focusing on the production of goods that give the greatest expected private benefits, in this case development for urban residential, industry, tourism and agriculture (Hatfield Dodds 2004; Grafton *et al.* 2004).

Table 2: Categories of market failure (adopted from Whitten and Shelton 2005 and OECD 1999).

Market failure	Referred to as	Comment
Lack of fully defined and defendable property rights for cassowaries	Public good ¹	Wildlife of any kind are non excludable in consumption. If a consumer can not exclude others from the benefits of their purchase, they are very unlikely to make a purchase. As a result it is very difficult to extract a charge for the provision of wildlife and there is therefore little incentive for private provision of the good beyond the producer's private benefit.
Lack of fully defined property rights with respect to ownership and transferability	Externalities ²	There are many beneficiaries from the provision of the cassowaries. Previous discussion highlights that these beneficiaries are dispersed across time and space. With poorly defined rights to ownership and transferability and temporally and spatially distributed beneficiaries, it is often too expensive to communicate benefits and costs associated with cassowary conservation or removal. With a lack of fully defined property rights, the value of the cassowary habitat and development impact on cassowaries more broadly remains external to decisions about the exchange and development of land.
High information costs and asymmetric information	Information failure	Whilst the information regarding the social benefits of cassowary conservation and the private cost of changed land management exists, the cost of market participants to gain all this information and consider them in exchange is prohibitively high.
High information costs – scientific uncertainty	Information failure	Uncertainty about the impacts of changed land management or even changed developer behaviour on the cassowary will always exist. The costs to determine the cause and effect relationship is high therefore it is costly to allocate property rights.
High information costs – monitoring impacts over time	Information failure	There is a large time lag between a management action and the ability to measure this action for success. Costs are incurred up front with rewards gained over a much longer time period. The long time lags also contribute to high monitoring costs which results in high cost of property right allocation, high defence cost as well as costly contracting and enforcement.

¹ A public good is one that is non-rival and non-exclusive in consumption. Defence is another example of a public good.

² Externalities occur when a valued impact occurs to a party that did not consent to that impact (Weiner and Vining 1992). Externalities also occur when it is too costly for those who are impacted to provide feedback to the impactor because the property rights are incomplete (Wills 1997; Whitten and Bennett 2005).

Conclusions: The need for appropriate government intervention

While cassowaries and the rainforest services they provide are highly valued by current and future Mission Beach residents and visitors, this value is not incorporated in the exchange of land and habitat that the cassowaries need to survive. The cumulative, ongoing and often significant indirect impacts of development are also not reflected in the market.

When the market fails to provide the socially optimal level of a good, government intervention may be justifiable (Murtough *et al.* 2002). There is a long history of government intervention for the provision of public goods such as natural places and habitat for significant and threatened species. The next paper in this series discusses these in relation to the cassowary both in terms of the protection of the cassowary generally and in terms of management of the development broadly and in terms of the impact on the cassowary.

References

- ABARE (2001) *Alternative policy approaches to natural resource management*. Background report to the Natural Resource Management Taskforce, Australian Bureau of Agriculture and Resource Economics (ABARE), Canberra.
- Bentrupperbäumer, J. M. (1998) *Reciprocal ecosystem impact and behavioural interactions between cassowaries, Casuarius casuarius and humans, Homo sapiens*. Townsville: Doctoral thesis presented to the School of Psychology, James Cook University.
- BioTropica Australia (2005) *A framework to establish lowland habitat linkages for the Southern Cassowary (Casuarius casuarius johnsonii) between Cairns and Cardwell*. Report commissioned by the Australian Rainforest Foundation, Cairns.
- Bromley, D. W. (1991) *Environment and Economy*. Blackwell, Oxford.
- Coggan, A., Hill, R., Whitten, S. and Harman, B. (In press) *Market Based Instruments, Ecosystem Services and Development in Mission Beach, Far North Queensland. Background Report 3: Institutions and structures currently in place for the management of development and the cassowary – What they do, what are the gaps and what does this mean?* Report to the Marine and Tropical Sciences Research Facility. Reef and Rainforest Research Centre Limited, Cairns.
- Coggan, A. and Whittten, S. (2009) *Market Based Instruments, Ecosystem Services and Development in Mission Beach, Far North Queensland. Background Report 1: Impacts of Development on Ecosystem Services*. Report to the Marine and Tropical Sciences Research Facility. Reef and Rainforest Research Centre Limited, Cairns (30pp.).
- Crome, F., and Moore, L. (1990) Cassowaries in North Eastern Queensland: Report of a survey and review and assessment of their status and conservation and management needs. *Australian Wildlife Research* 17, 369-85.
- DEH (2006) *The Southern Cassowary (Casuarius casuarius johnsonii): Review of the ecology values and threats in the Wet Tropics bioregion, Queensland*. Department of the Environment and Heritage, Canberra.
- Grafton, R., Adamowicz, W., Dupont, D., Nelson, H., Hill, R. and Renzetti, S. (2004) *The economics of the environment and natural resources*. Blackwell Publishing, United States.
- Hatfield Dodds, S. (2004) *Improving incentives for biodiversity conservation: Policy options and issues for discussion*, Canberra.
- Kutt., A. S and King, S. M. (2002) *Distribution of cassowary habitat in the Wet Tropics Bioregion, Queensland*. Queensland Environment Protection Authority, Townsville.
- Kasper, W. (1998) *Property Rights and Competition*. The Centre for Independent Studies, Canberra.
- Latch, P. (2007) *Recovery plan for the southern cassowary Casuarius casuarius johnsonii 2007-2011*. Report to Department of the Environment and Heritage, Canberra. Queensland Parks and Wildlife Service, Brisbane.

Moore, L. A. and Moore, N. J. (2001) *The Cassowaries of Mission Beach: Population number, densities, distribution, demography and implications for conservation*. Wet Tropics Management Authority, Cairns.

Moore L. A. and Moore, N. J. (1998) *Cassowary Conservation Roads: A cassowary management strategy and road upgrade assessment for El Arish and Tully – Mission Beach Roads, Mission Beach*.

Murtough, G., Arentino, B. and Matysek, A. (2002) *Creating Markets for Ecosystem Services*. Ausinfo, Canberra.

Nunes, P. and van den Bergh, J. (2001) Economic valuation of biodiversity: sense or nonsense? *Ecological Economics* 39(2001): 203-222.

OECD (1999) *Handbook of incentive measures for biodiversity: Design and implementation*. Organisation for Economic Cooperative and Development (OECD), Paris, France.

Quadrio, J. (2006) *Rearing cassowary orphaned chicks*. Queensland Department of Main Roads, Report No 1, March.

QDNRW (2006) *Essential Habitat Mapping Fact Sheet*. Queensland Department of Natural Resources and Water. (http://www.nrw.qld.gov.au/vegetation/code_review_06/eh_review.html) (Accessed 22/03/07).

Stoneham, G., Crowe, M., Platt, S., Chaudhri, V., Soligo, J. and Strappazzon, L. (2000) *Mechanisms for Biodiversity Conservation on Private Land*, Melbourne.

Weimer, D. and Vining, A. (1992) *Policy analysis concepts and practice*, Pearson Prentice Hall, New Jersey.

Whitten, S. and Bennett, J. (2005) *Managing wetlands for private and social good*, Edward Elgar, Cheltenham.

Whitten, S. and Shelton, D. (2005) Market for Ecosystem Services in Australia: Practical design and case studies. Paper Presented to a Workshop titled "Payments for Environmental Services in Developed and Developing Countries" Organised by the Centre for Development Research, University of Bonn (ZEF); and the Centre for International Forestry Research (CIFOR). 15-18 June 2005, Titisee, Germany.

Wills, I. (1997) *Economics and the Environment; a signalling and incentives approach*, Allen and Unwin, St Leonards.

Young, M., Gunningham, N., Elix, J., Lambert, J., Howard, B., Grabosky, P. and McCrone, E. (1996) *Reimbursing the future*. A report to the Biodiversity Unit of the Australian Commonwealth Department of Environment, Sport and Territories, Canberra.

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Marine and Tropical Sciences Research Facility
PO Box 1762
CAIRNS QLD 4870

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