# THE SOUTHERN CASSOWARY (*CASUARIUS CASUARIUS JOHNSONII*) POPULATION IN MISSION BEACH, QUEENSLAND, NORTHERN AUSTRALIA: THREATS AND PROTECTIVE ACTIONS

**Final Thesis of Animal Management**
**Wildlife Management**
**2012**

**Teresia Robitschko & Meike Schlatter**

University of Applied Sciences
VAN HALL LARENSTEIN
PART OF WAGENINGEN UR

AGA
Aktionsgemeinschaft Artenschutz e.V.
Action Campaign for Endangered Species (ACES)

# THE SOUTHERN CASSOWARY (*CASUARIUS CASUARIUS JOHNSONII*) POPULATION IN MISSION BEACH, QUEENSLAND, NORTHERN AUSTRALIA: THREATS AND PROTECTIVE ACTIONS

**Final Thesis of Animal Management**
**Wildlife Management**
**2012**

Project Number**:** 594000

Leeuwarden, 11 July 2012

**Compiled by:**
**Teresia Robitschko** **Student number: 890206002**
**Meike Schlatter** **Student number: 820919004**
Van Hall Larenstein, University of Applied Science, the Netherlands
Department of Animal Management
(Wildlife Management)

**Supervisors of Van Hall Larenstein**
Berend van Wijk (Wildlife Coordinator)
Jelmer van Belle (Wildlife Lecturer)

**Supervisor of the Aktionsgemeinschaft Artenschutz e.V. (AGA)**
Birgit Braun (Conservation Projects Coordinator)

Picture on front page: http://bjornfree.com/galleries.html

University of Applied Sciences
VAN HALL LARENSTEIN
PART OF WAGENINGEN UR

AGA
Aktionsgemeinschaft Artenschutz e.V.
Action Campaign for Endangered Species (ACES)

## Table of contents

Summary ..... 1
Introduction ..... 1
Mission Beach ..... 2
The Southern cassowary ..... 2
Threats to the cassowary population ..... 3
Methods ..... 3
Literature review ..... 4
Questionnaire survey ..... 4
Results ..... 4
Discussion and conclusion ..... 17
Recommendations ..... 19
Zusammenfassung ..... 20
References ..... 20
Appendix Questionnaire .....

# THE SOUTHERN CASSOWARY (*CASUARIUS CASUARIUS JOHNSONII)* POPULATION IN MISSION BEACH, QUEENSLAND, NORTHERN AUSTRALIA: THREATS AND PROTECTIVE ACTIONS

TERESIA R. S. ROBITSCHKO and MEIKE SCHLATTER

## *Summary*

The Southern cassowary *(Casuarius casuarius johnsonii)* is a vulnerable species in Northern Australia. Literature research on the cassowary population in Mission Beach, Queensland, revealed the vulnerability by identifying various threats endangering the cassowaries. Those threats were assessed by various research projects. Different actions were suggested and partly implemented for the protection of this species. The numerous amount of institutions dedicated to the conservation of the cassowaries underline the problematic situation of this bird. The additionally accomplished survey questionnaire of experts on site executed in the present study highlights the current situation of the cassowary and illustrates the opinion of experts at present. According to the literature and these experts, the main threat is the ongoing habitat loss and fragmentation whereas road kills cause the highest mortality. A remarkable finding is the inaccurate and irregular elicitation and documentation of precise population numbers and remaining cassowary habitat size in the Mission Beach area. Although conservation actions are implemented, the population is still declining. Consequently, it is essential to review and improve the planned and performed mitigation strategies. In order to do so, more detailed research on the cassowary population and the remaining habitat in Mission Beach is necessary to allow predictions of the population development and concentrate on most successful actions.

***Keywords*** Wet Tropics - literature review - habitat loss - road kills - dog attacks - cyclones

## *Introduction*

Nowadays a growing number of species is endangered or threatened by extinction due to increasing human influences. One example of such a vulnerable species is the Australian Southern cassowary (*Casuarius casuarius johnsonii*) which is endemic to the north-western coastal area of Queensland, Australia (IUCN 2011). (Figure 1)

The Southern cassowary in the Mission Beach area is particularly threatened by substantial habitat loss and fragmentation as a result of an increase of human settlements and agriculture (Moore 2003).

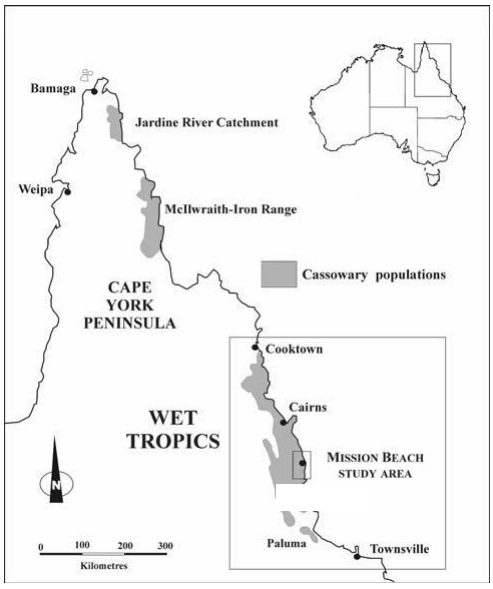


**Figure 1: Distribution of the Southern cassowary populations in Queensland, Australia.** (Moore 2007)

In the following, the term cassowary refers to the species Southern cassowary. The cassowary

population in Queensland is divided into the Cape York population (northern population) and the Wet Tropics population (southern population). The Wet Tropics population is already listed as endangered, whereas the Cape York population is only listed as vulnerable under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 [EPBC Act] and under the Queensland Nature Conservation Act 1992 [NC Act]. (Latch 2007)

There are no exact numbers for the population of all Australian cassowaries at present. In 2002 the population size was estimated at 1,500-2,500 individuals (IUCN 2011) whereas at present the population is considered to be even smaller than 1000 birds (Save the Cassowary 2012). According to Crome and Moore (1990) the Wet Tropics population was estimated between 2,500–4,000 individuals in 1988 and in 2001 at less than 1,500 adult cassowaries (Moore & Moore 2001).
Mission Beach in northern Queensland is well known for its primary distribution of cassowaries in the Wet Tropics (Moore 2007, Bradford & Westcott 2010). Different field surveys by Crome and Bentrupperbäumer (1991 & 1992), Goosem (1992) and Moore (1998) revealed a varying presumed size of the Mission Beach cassowary population from less than 52 to 180. According to a survey of Moore (2003) 110 cassowaries could be found in Mission Beach in the year 2000. The actual number of cassowaries in Mission Beach is expected to be between 40 to 200 animals (Rainforest Rescue 2012, personal communication, Millerd 2012). Taylor (2009) stated that local research by L.A. Moore reveals the possibility of an overestimation of the cassowary population in Mission Beach and surroundings by 6 times.

*Mission Beach*
The coastal village Mission Beach has 3,500 inhabitants and is located in the so called Cassowary Coast Region between the cities Cairns and Cardwell (Wet Tropics 2010). The area is known for the recurrent occurrence of cyclones (Turton 2011). Mission Beach is surrounded by the Wet Tropics and the Great Barrier Reef. This forms the only area worldwide where tropical rainforest directly borders a coral reef coast. The area is one of the 4 priority biodiversity hot spots in Northern Queensland. It comprises the highest density of cassowaries in Australia and has the best coastal to highlands rainforest corridor in the Wet Tropics. (Hill *et al.* 2010)

*The Southern cassowary*
The cassowary is the largest native vertebrate in Australian rainforests and is part of the ratite group of large flightless birds (Westcott & Reid 2002 and Latch 2007). The diet of this frugivore includes fruits from up to 238 different plant species (Westcott *et al.* 2005). Of these plants ca. 100 depend on the cassowaries for the dispersal of seeds (Crome & Moore 1990). Therefore, cassowaries play a significant role as a ‘keystone’ species in rainforest ecosystem dynamics (Crome & Moore 1990 and Latch 2007). Besides fruit, the cassowary also feeds on small vertebrates such as snails, fish, frogs, bird nestlings and eggs, mice and rats as well as on insects (Barker & Vestjens 1989, Marchant & Higgins 1990, Bentrupperbäumer 1998 and Buosi & Burnett 2006).

The cassowary is polyandrous and lays 2 to 3 clutches of 3 to 5 olive green eggs per breeding season from June till October (Buosi & Burnett 2006 and Grummt & Strehlow 2009). The incubation period of the eggs is 50 days and rearing of the chicks lasts until 9 or rarely up to 18 months and is the responsibility of the male (Bentrupperbäumer 1998). Male cassowaries mostly breed only once every 3 years, while ca. 20% possibly breed twice in this period (Bentrupperbäumer 1998 and Moore 2003). Cassowaries mature at about three years of age (Bentrupperbäumer 1998) and can get over 29 years old in the wild (Moore 2003), while in captivity they can live up to 50 years (Crome & Moore 1988).

Cassowaries mainly live in flat areas with dense vegetation, such as tropical rainforests and associated habitats like mangroves, open woodlands, swamps and areas with a high fruit supply (Marchant & Higgins 1990, Moore 1996 a-b, Bentrupperbäumer 1998 and Moore 1999 a-c). Additionally, fresh water sources for drinking and bathing are essential (Crome & Moore 1988, 1990, Crome & Bentrupperbäumer 1992 and Bentrupperbäumer 1998). Most cassowaries of the Mission Beach area occur in the lowlands (<20 m above sea level) (Crome & Bentrupperbäumer 1991 and Bentrupperbäumer 1998). Their distribution range differs seasonally (IUCN 2011). The home range of a cassowary is generally between 0.5 and 5 $km^2$ in the coastal lowland and can reach up to 12 $km^2$ in the upland region. Yearly changes in the home range occur depending on the season, fruit availability and environmental conditions. (Crome & Bentrupperbäumer 1992, Moore 1996a-b, 1998, Bentrupperbäumer 1998 and Moore 1999a-c). In Mission Beach, however, the reported home range of the cassowary is considerably smaller and varies between 2.13 and 2.06 $km^2$ (Moore 2007). The cassowaries are territorial and solitary only tolerating other cassowaries during the breeding season (Latch 2007). Female cassowaries have a larger home range partially overlapping with those of males (Marchant & Higgins 1990, Bentrupperbäumer 1998 and Garnett & Crowley 2000).

*Threats to the cassowary population*

According to Latch (2007), the cassowary population is endangered due to the following threats (listed in decreasing order of importance):

Habitat destruction, in the following including habitat loss, degradation and fragmentation, road kills, dog attacks, hand feeding, diseases and natural catastrophes (cyclones). Based on these above mentioned threats, Latch (2007) suggested several actions which could help to protect the cassowary population in this area.

*Aims*

The aim of this literature review and questionnaire survey is to elucidate information regarding the threats and the suggested and already implemented actions on the protection of the cassowary population in Mission Beach, Queensland, Australia. In addition recommendations for improvement and further development will be drawn.

## *Methods*

This article is based on a literature review supplemented by a survey of local experts. The information obtained from the literature was compared with the outcome of the questionnaire survey. Differences or similarities between literature and expert opinions on site were highlighted to get hints for changes in the endangerment of the cassowaries. In this process,

figures on habitat destruction, road kills, dog attacks, diseases, hand feeding and cyclone appearance were compiled and viewed against the different papers and the expert opinions. The status of implementation of the suggested actions and the effect of their execution on the threats to the cassowary population were examined.

*Literature review*
Research articles in scientific journals, other publications and internet sources were used to identify the threats to the cassowaries and the suggested and implemented protective actions. The outcome of the literature review in respect to threats and actions was summarized and missing data indicated. Recommendations were drawn and given in the discussion and table 4.

*Questionnaire survey*
The conducted survey was performed in the form of a questionnaire via e-mail with open and closed questions. The questionnaire was divided in 6 parts: a. personal information, b. size and composition of the population, c. kind and impact of the threats, d. planned and implemented actions, e. involvement of stakeholders and f. future development and prediction for the population. For several questions six qualitative ranking scales were provided. Since most of the available data about the threats are in a time frame of the last 15 years, this time frame was chosen for the questionnaire and short (1 year) and long term (>3-5 years) periods were compared. The questionnaire was sent to 25 experts and organizations in Queensland, Australia. The survey was analyzed with spreadsheet programs (Excel 2007 and SPSS 17), depending on the type of question as follows:
For closed questions with qualitative answer options the possible answers were listed and the most frequent answer indicated. For open quantitative questions either the most frequent number or the lowest and highest numbers were given. The diverse rankings were examined and the most frequent answer calculated. Answers of open qualitative questions were summarized.

In the questionnaire section in the results, only the answers of the participants of the questionnaire were stated without identifying the person.

## ***Results***
The literature review revealed that there are mainly the same authors dealing with information on threats and on actions concerning the cassowary population in Mission Beach. These authors are J.M. Bentrupperbäumer, P. Buosi, S. Burnett, F.H.J. Crome, M. Goosem, C.P. Kofron, P. Latch, L.A. Moore, S.M. Turton and D.A. Westcott. According to them, cassowaries are exposed to different direct or indirect threats. The tables 1 and 2 display an overview of the used literature and the available information given. Furthermore, table 2 shows the positive and negative effects of the actions. The threats and suggested and implemented actions described in these publications as well as outcomes of the 3 returned questionnaires are listed in the following paragraphs.

**Table 1: Overview on general information and threats used literature**

| General/threats | # of references publications | # of references internet | Available information | Missing information |
|---|---|---|---|---|
| **Cassowary biology** | 20 | 1 | See paragraph Southern cassowary | - |
| **Cassowary Population** | 11 | 3 | Whole Australia 1500-2500 (2002); >1000 (2012); Wet Tropics 2500-4000 (1988); less 1500 (2001); Mission Beach 52-180 (1991-1998), 110 (2000) and 40-200 (2012) | Exact data on population in Mission Beach; sex ratio and age distribution; reproduction, birth and mortality rate |
| **Habitat destruction** | 6 | | 80% destructed, over last 100 years | Size of destructed and remaining Mission Beach cassowary habitat |
| **Road kills** | 8 | 2 | See Figure 2 | Consistent annual data |
| **Dog attacks** | 3 | 1 | 13 deaths (1986-2000; excluding 1989/1990); 5 deaths (1986-1988); 6 deaths (1992-2005) | Consistent annual data |
| **Hand feeding** | 5 | | - | - |
| **Diseases** | 3 | 1 | 2 deaths (1986-1988); 6 deaths (1986-2000; excluding 1989/1990); 1 death (2008) | Consistent annual data |
| **Cyclones** | 8 | 2 | 18-30% deaths (after 'Larry' 2006); 50% deaths (2006-2007); 14 deaths and nearly all chicks vanished (2006-2007); 19 deaths (2011-2012) | Precise data on population and cassowary deaths in Mission Beach |
| **Feral Pigs** | 6 | | - | No annual data on pig incidents |
| **General threats** | 1 | | - | - |

**Table 2: Overview of actions stated in used literature and their effects**

| Actions | # of references publications | # of references internet | Action | Positive effects | Negative effects |
|---|---|---|---|---|---|
| **Cassowary biology** | 20 | 1 | Planned research for PVA | Better understanding of the species | - |
| **Cassowary population** | 11 | 3 | - | - | No exact data available |
| **Habitat destruction** | 2 | 4 | Buy back corridor; tree planting | Linkage; reforestation | Private landowners not willing to give up land; long growth duration |
| **Road kills** | 8 | 1 | Culvert, Overpass & fences; | Enables save road crossing; | Cassowaries not fond of culverts; prefer overpasses; fences can lead to injuries and separation |
| | | | Speed reduction; Tully-Mission Beach Road Model; | Minimize deaths; successful | Inhabitants not willing to reduce speed; not suitable for all areas |
| **Dog attacks** | 2 | | Be Cass-O-Wary Programme | Creating awareness of dog cassowary interactions | More restriction for dog owners |
| **Hand feeding** | 1 | | Be Cass-O-Wary Programme | Illustrate effects of hand feeding in order to prevent it | Hard to change habit of people |
| **Disease** | 3 | | - | - | - |
| **Cyclone** | 3 | 1 | Feed stations | Support food availability; keeps cassowaries from roads; possibility to assess population and identification | Create dependence; dispersal of non-rainforest seeds due to regular fruit usage for stations |
| **Feral pigs** | 6 | | Trapping and dog hunting | Eliminate pigs | Danger for cassowaries to get caught in traps or shot by hunters in order to protect dogs from cassowary attacks |
| **General activities** | 3 | 2 | Rehabilitation centre | Rehabilitation and release of sick and injured cassowaries | Translocations are difficult |

## 1. Habitat destruction

*1.1 Indirect threat - literature review*

As typical for most endangered species worldwide, habitat destruction, especially habitat loss, is the main threat to the cassowary (Latch 2007). The original cassowary habitat in Mission Beach is permanently reduced by habitat loss, fragmentation and degradation, resulting from clearing of the rainforest for agriculture and urban development (Moore 2003 and Latch 2007). Through these clearings over the last 100 years, 80% of the former cassowary habitat has been destroyed (Latch 2007 and ARF 2012). Approximately 40% of the cassowary habitat in Mission Beach is not protected (Hill *et al.* 2010). Despite the general agreement among the authors on the impact of habitat loss on the cassowary population as most fatal, no precise data of the destroyed habitat in the Mission Beach area is documented in the literature. A fragmented rainforest is more vulnerable to cyclones and needs longer recovery duration from the caused destruction (Laurence & Curran 2008 and Turton 2011). Fragmentation isolates the cassowary population and restricts their movement (Latch 2007). Cassowaries have a long life span and may remain in their home range even without any breeding (Crome and Moore 1990). As a consequence of habitat loss and fragmentation the cassowaries are forced to leave their habitat to forage and search for mating partners. Especially at times of natural food restrictions, particularly low fruit abundance, cassowaries migrate to non-rainforest habitats to search for additional food resources. (Marchant & Higgins 1990, Crome & Moore 1990, Bentrupperbäumer 1998 and Garnett & Crowley 2000) Weed invasion, logging and a changed fire regime lead to continuous habitat degradation. As a result natural shelters, breeding sites and food sources are diminished. (Latch 2007) A decrease in cassowary numbers occurs due to habitat loss and degradation but also due to additional influences on their home range (Bentrupperbäumer 1998). Habitat destruction leads to an increase of road kills, dog attacks and enhances further threats like hand feeding (Latch 2007).

*Questionnaire*

All participants of the questionnaire support the statement of habitat destruction being the main threat to the cassowaries on the short and long term. They pointed out that due to fragmentation of the habitat, isolated cassowary populations have no opportunity to disperse into an unaffected habitat.

*1.2 Actions - literature review*

Due to the fact that the biggest threat to the cassowary is the diminishing habitat, Queensland Environmental Protection Agency [QLD EPA] mapped over 800,000 ha essential cassowary habitat in the Wet Tropics. Of this habitat, 84% is protected within the Wet Tropics World Heritage Area [WTWHA], 5% is under protection of other tenures, and ca. 11% is outside these areas, mainly on freehold land. This latter area draws more attention to conservation measures. The Nature Refuge Programme protects more cassowary habitat and financially supports maintenance of landowner tenures. The involvement of landowners in the protection of the cassowary is attempted and the connection of private and protected land favored. Important corridors and linkages are identified for the Wet Tropics Conservation Strategy during the process of habitat mapping. Thereby rehabilitation and protection of essential cassowary habitat areas is determined. Adequate conservation of these areas is endorsed and local and regional areas specified. Data on areas threatened by fragmentation and other

impacts, cassowary life history traits, landholders, development and conservation of the regional ecosystem is consulted. (Latch 2007)

To assure the intactness and security of the cassowary habitat, the institutions Rainforest Rescue, Terrain Natural Resource Management [Terrain NRM] together with Community for Coastal and Cassowary Conservation [C4] raised money to buy back the Garrett corridor in Mission Beach (Mission Beach Cassowaries 2010). Another program of planting 10,000 trees was established to restore corridors between fragmented areas. Corridors are already created and need further protection to ascertain the safe movement of the cassowary. (Rainforest Rescue 2008) Owners of private habitat that is linked and forms corridors for the cassowaries, are encouraged by Terrain NRM to protect it from future destruction (Taylor 2009). The Australian Rainforest Foundation [ARF] plans a 250 km wildlife corridor in the Wet Tropics, between Cairns and Cardwell, with Operation Big Bird (ARF 2012). Additionally, a corridor plan for Mission Beach is financed by ARF and cassowary corridor recreation was funded by Australian Government projects (Latch 2007). A new Cassowary Coast Planning Scheme is currently processed by the Cassowary Coast Regional Council, including mapping of the Mission Beach habitat linkages, identified by Terrain NRM (Cassowary Coast Regional Council 2012). Coastal habitats and foot slopes form the basis of 25 corridors, distinguished by the Wet Tropics Regional Vegetation Management Codes and the Wet Tropic Conservation Strategy. The efficiency of these corridors is currently evaluated with a monitoring programme. The movement of the cassowary population and the use of corridors are investigated with genetic analysis. (Latch 2007)

*Questionnaire*

The most important actions, which were stated by the expert survey on the long term, are the buyback of corridor land, revegetation, protection and restoration of habitat and research projects to improve knowledge about the cassowaries and the population numbers. According to these experts, the interest of the inhabitants in participating in tree planting actions is medium to high, however, the success of the implementation appears low to medium. It was mentioned that there is only low budget and little follow up management available for the small organizations which carry out these actions. Buyback receives very low to medium interest with little success since land is too expensive and not affordable. In addition not all land owners show interest in cassowary conservation. The interest in building corridors and their protection is medium to very high but the success appears only low to medium. Many landowners seem not interested in conservation and are afraid to lose their land, when research reveals that their property is valuable as a suitable corridor. The recommended actions of the participants are the regaining of suitable land to improve connectivity and the examination of restoration programmes. Corridor land and revegetation are essential to reduce habitat destruction for which a substantial amount of money is necessary.

## 2. Road kills

### *2.1 Direct threat - literature review*

Literature review revealed that road kills cause the highest mortality rate among all threats (Crome & Moore 1990, Moore 2003, Kofron & Chapman 2006 and Latch 2007). All traffic at Mission Beach passes through cassowary habitat, fragmenting the area and forcing cassowaries to cross roads while foraging and roaming through their habitat (Latch 2007 and

Chenoweth 2008). Of the known cassowary population at Mission Beach, 67% crosses the major access roads of El Arish to Mission Beach, Tully to Mission Beach, Wongaling and South Mission Beach Roads. As a consequence, two-thirds of the cassowary population is constantly threatened by road accidents. (Chenoweth 2008) Mainly adult birds are involved in road accidents leaving orphaned chicks behind (Kofron & Chapman 2006). Between 1989 and 2010, the percentage of cassowary deaths due to road kills varies from 70% to 89% of all known mortalities (Kofron and Chapman 2006, Latch 2007 and Goosem *et al.* 2011). Since cyclone 'Larry' in 2006 till 2007, 82% of reported deaths were due to road incidents. Road kills reveal ca. 70% of post-cyclone cassowary deaths (Goosem *et al.* 2011).

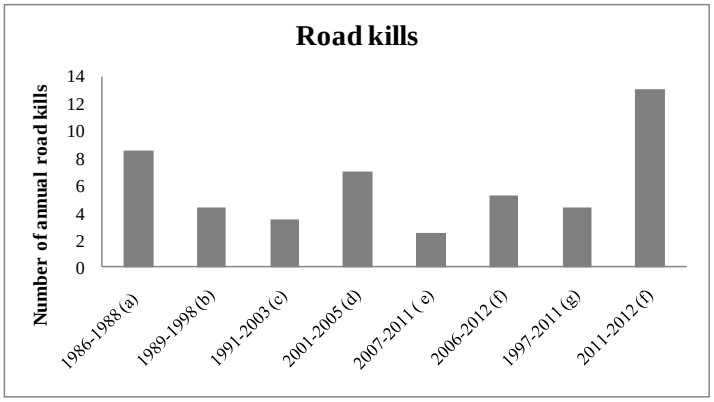


**Figure 2: Annual numbers of reported road kills from 1986-2012** ((a) CAFNEC 2012, (b) CAFNEC 2012 and Moore & Moore 1998, (c) Moore 2003, (d) QPWS, unpublished paper, (e) Goosem *et al.* 2011, (f) Save the Cassowary 2012 and (g) Latch 2007)

An illustration of the reported annual number of road kills during the last 26 years is summarized in Figure 2. There are no exact annual recordings of such numbers in the literature, but rather summarized road kill data are given by the different reports which are based on periods of different and partially overlapping length. Therefore calculated annual rates for the same years of different authors are included. Despite this inaccuracy it is evident that the annual mortality rate due to road kills fluctuates between about 3 and 8 animals per year and only the most recent report suggest a higher number. Thus, no obvious trend is apparent. The highest numbers stem from the reports for the years 1986 to 1988 and 2011 to 2012. Both periods are post cyclones.

Figure 3 shows the annual road kills from 1992 to 2012 recorded by Queensland Parks and Wildlife Service [QPWS] and Queensland Department of Environment and Heritage Protection [DEHP]. Just as the stated numbers in literature, the annual numbers of road kills in this unpublished record fluctuate over the last 20 years. They oscillate between 3 and 11 and the highest reported numbers of annual road accidents occurred in the years 1992, 2004, 2006 and 2011. Unlike the highest numbers in literature, there is no correlation between the peaks in deaths and cyclones. According to QPWS (2012) there were an additional 11 more possible road kills between

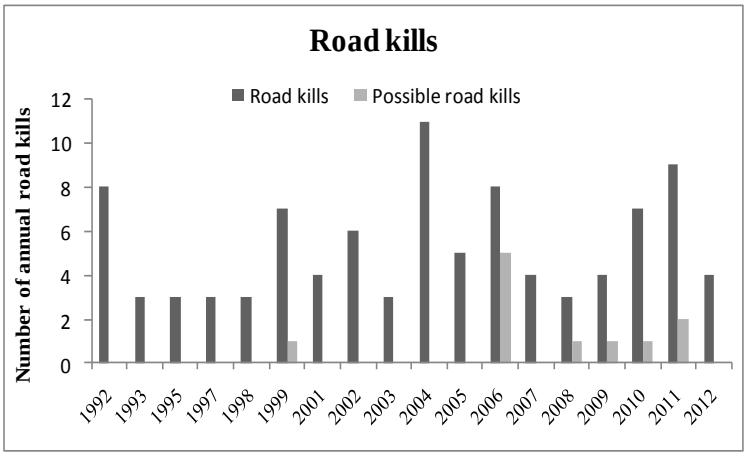


**Figure 3: Annual numbers of reported road kills from 1992-2012** (QPWS 2012 and DEHP 2012, unpublished data)

1999 and 2011. However, the number of road incidents is presumably higher, since not all road kills are reported (Latch 2007).

*Questionnaire*
The statements given in the questionnaire to this point are more diverse, as road kills are indicated as first, second or third highest threat on the short and long run. The experts pointed out that mainly locals and transient workers using utility vehicles and cars are responsible for incidents with cassowaries.

*2.2 Actions - literature review*
The Queensland Department of Main Roads [QDMR] initiated strategies to reduce road mortality of the cassowary. Reducing the speed limit, extensive signage and traffic calming were established. Cassowary crossing points, 'black spots' of cassowary incidents and driver behavior were monitored by EPA. The already implemented Tully-Mission Beach road model includes cassowary crossing warning signs, relative size signs, cassowary conservation zone signs, transverse line markings, reduction in thickness and an increase in the spacing and frequency of separation lines, landscaping and fencing of bridges and culverts, rumble strips and verge clearing (Chenoweth 2008). Moore & Moore (1999 a-c and 2001) determined several crossing points of cassowaries and mitigation strategies for road kills, which were considered in the planning of the model (QDMR 2001). QDMR was responsible for further establishment (QDMR, 2001). At present, the James Cook University is re-assessing the model and it will be adjusted and compared with Moore & Moore (1999) and other later assessments (Chenoweth 2008). The model of the Tully-Mission Beach Road is used as cassowary management strategy for further road management and maintenance. A database for road accidents, injuries or deaths of cassowaries was introduced by EPA and further developed by the Department of Environment and Resource Management [DERM], QPWS and DEHP. Road-strike data can be analyzed for population viability models (Latch 2007). As a mitigation strategy under- and over passes in the form of tunnels and bridges as well as culverts were set up and are already used by cassowaries (Moore & Moore 1999 and Goosem *et al.* 2011). According to researchers culverts are not quite suitable for cassowary movements, whereas elevated road structures are the most suitable strategy to enable cassowaries to cross roads (Chenoweth 2008). To prevent cassowaries from crossing roads, fences were set up, leading the birds to over- and underpasses. However, fences can form a threat to the cassowary by restricting its movement and causing entanglement, which results in injuries (Bentrupperbäumer and Goosem 2005). Cassowaries get exhausted or injured when caught up in fences or cornered by dogs. After cyclones fences can lead to entrapments. Moreover, fences separate and fragment habitats, home ranges and the cassowary population itself even more. A well designed fence for this purpose does not exist yet. Earth mounds form a reasonable alternative for fences to guide cassowaries to road cross opportunities. (Chenoweth 2008)

A variety of colored visible cassowary crossing markers such as reflectors, road shoulders, and markers on the road surface (e.g. foot prints) were introduced. Wildlife detectors as for example roadside flashing lights were suggested to make drivers attentive to road crossings. Their success is questionable, since the risk of only sensing the movement of large animals

exists. As a result small chicks or young sub adults might not trigger the signage. A speed limit from 80 km/h to 60 km/h was partly initialized. (C4 2010) To monitor traffic volume and speed, traffic counters were introduced in Mission Beach (MTSRF 2009).
According to C4 (2010), the following strategies to reduce road mortality were suggested: Speed limit is recommended to be reduced depending on time of day (rush hour and cassowary activity) and breeding season. Furthermore, a restriction on overtaking is partially initiated. In addition, speed bumps and roundabouts could be introduced as speed reduction measures. Mobile or fixed speed cameras could be placed in areas with high cassowary abundance and crossing points. A driving training for local drivers and information on cassowary road incidents could be offered. To influence drivers' behavior, a fine by the Queensland and Australian Government Legislation for road kills could be implemented. As a negative effect this can lead to more unreported road incidents and rejecting help of injured birds. Road verges should be slashed, cleared and maintained on a regular basis. However, such a free view could result in an increase of speed. Weed growth and access for feral animals could be enhanced. Low growing vegetation which is not attracting cassowaries or other animals to feed on could be replanted. Earth mounds form an alternative to fences to keep cassowaries from crossing roads. The usage of roads which are not frequently crossed by cassowaries should be encouraged. To enable more mitigation options such as fauna crossing at local government costs, state roads could be transferred to local government road management. Public transport possibilities, walk ways and bicycle paths could be introduced to reduce traffic. (C4 2012) It is essential to do more research on the suggested strategies, like underpasses, by QDMR. Meanwhile the implementation of main essential strategies in all recognized areas is necessary. (Latch 2007)

*Questionnaire*
In the returned questionnaires as significant action, the direct reduction of speed limit to no more than 60 km/h on all roads off the highway was proposed. However, the acceptance of a reduced speed limit is low and therefore the success of such an action is viewed only low to medium. At present, these experts do not recognize helpful measures of the local government to decrease the number of road accidents on the state roads. The way of road alignment apparently does not encourage a reduction of speed. The experts indicate, that the tactic to revegetate road verges to reduce the clear view for drivers to slow them down, already works in other areas in Queensland and should be further developed. On the other hand an increase in visibility leads to a better reaction time of the drivers.

## 3. Dog attacks

### *3.1 Direct threat - literature review*

The second main cause of cassowary deaths is dog attacks (Kofron & Chapman 2006 and Latch 2007). Domestic and roaming dogs are responsible for these deaths. Chicks and sub-adults are especially vulnerable to dogs. The encroachment of rural settlements results in more dogs approaching cassowary habitat. (Latch 2007) In the Mission Beach area 5 cassowaries were killed by dogs between 1986 and 1988 (CAFNEC 2012). Between 1986 and 2000 (excluding 1989-1990) 13 cassowary deaths from dog attacks were reported in the same area (Moore 2003). Other reported dog attacks occurred between 1992–2005, indicating 6 cassowary deaths, of which five were sub adults or chicks. Just like road accidents, the

assumed number of dog attacks is likely to be higher due to the fact that not all of them are recorded. (Latch 2007) According to QPWS and DEHP (unpublished data, 2012), 5 dog attacks were recorded in 2006 and 4, with an additionally 3 possible dog attacks in 2011.

*Questionnaire*
In the questionnaires dog attacks were classified as number 1, 2 or 3 threat in the short and long term, just like road accidents. The participants stated that roaming and hunting dogs are responsible for attacking cassowaries.

*3.2 Actions - literature review*
The 'Be Cass-O-Wary' Programme, designed by the cooperation of the Cassowary Advisory Group [CAG], EPA and the Wet Tropics Management Authority [WTMA], stimulates the local community to participate in the control of roaming dogs and points out the negative effects of dog attacks on cassowaries. With support from local councils, a responsible dog ownership education programme was developed. To decrease the occurrence of roaming dogs, subsidies for control regulations and compulsory dog registration were raised. Public awareness is evoked by promotional campaigns and educational material. (Latch 2007) Dog-free and off-leach areas are taken into consideration to protect cassowaries and their environment and assure the health of the dog itself. In cooperation with the local community, sub-ordinate local laws are designed under the new Animal Management Act. (Hill *et al.* 2010)

*Questionnaire*
The interest in the 'Be Cass-O-Wary' Programme is indicated as only very low to low, therefore resulting in a low to medium success. Dog owners are not willing to accept restrictions from the local authorities concerning their dogs on their own property. Experts' recommendations concerning suggested and implemented actions for the threats are to control domestic dogs and shoot feral dogs. To prohibit interactions between dogs and cassowaries, dog exercise areas for the public should be offered.

## 4. Hand feeding

*4.1 Indirect threat - literature review*
The fact that people hand feed cassowaries illegally induces a conflict between humans and cassowaries (Latch 2007). This hand feeding draws the cassowaries more to roads and rural settlements and leads to an increase of road kills and dog attacks (Crome and Moore 1990, Bentrupperbäumer 1998, Buosi & Burnett 2006 and Latch 2007). Hand feeding can also encourage aggressive behavior of cassowaries towards humans. This change in natural behavior can lead to bird attacks against humans. From 150 cassowaries attacking humans in Queensland, 75% were previously fed by humans. In Mission Beach the number of known attacks is 54. (Kofron 1999)

*Questionnaire*
The experts characterized hand feeding highly diverse as a threat to cassowaries between levels 1, 3 and 4 in the short and long run.

*4.2 Actions - literature review*

To inform the community, an educational awareness Programme 'Be Cass-O-Wary' was designed. Through multimedia such as brochures, signs, posters and television announcements, attention was especially drawn to the negative effects of hand feeding. In addition, educational material for schools, zoos and wildlife parks was provided by WTMA. (Latch 2007)

*Questionnaire*

Community education focusing on the uniqueness of cassowaries is viewed as important on the short term. Thereby, the enlightening of the negative effects of hand feeding on cassowaries is essential, because its reduction could lead to a decrease of cassowaries approaching rural settlements. On the contrary, the interest in the 'Be Cass-O-Wary' Programme appears only very low to low resulting in a low to medium success. It is difficult for the police to be aware of people feeding cassowaries on their own property. As cassowaries have a long life span, people can get attached to them when feeding them over a longer period of time and their willingness to stop this problematic attitude declines. Not all people are willing to take responsibility for their actions which complicates the situation. Recommendations are difficult to implement since the habit of people is hard to change, especially when they are used to feed cassowaries for years. Legislation to prohibit hand feeding should be enforced by the state government.

## *5. Disease*

*5.1 Direct threat - literature review*

The health of the cassowary is threatened by different diseases and parasites. The most common are Avian tuberculosis and Aspergillosis, whereas tuberculosis is assumed to be the main disease. However, the total number of reported deaths due to diagnosed diseases is very low. (Latch 2007) There were 2 recorded deaths of cassowaries from diseases in the years 1986-1988 (CAFNEC 2012). Between 1986 and 2000 (excluding 1989- 1990) 6 cassowaries died due to diseases such as *Mycobacterium spp., Aspergillosis spp., Salmonella spp., Pasteurella spp.*, acute nephritis and severe liver damage (Moore 2000 a-b). According to L.A. Moore (2008) one cassowary died from Avian tuberculosis.

*Questionnaire*

The levels 4, 5 and 6 marked in the questionnaires again reveal the low impact of diseases on cassowaries on the long term. The participants also indicated tuberculosis as a main disease confirming the result of the literature review.

*5.2 Actions - literature review*

Hill et al. (2010) recommended an investigation of the epidemiology and spreading of diseases in cassowary populations. Difficulties in researching diseases occur due to limited data (Latch 2007). Further research on DNA analysis, disease load studies, cause and state of death and records of diseases is planned (Latch 2007 and Chenoweth 2008). The occurrence of Avian tuberculosis and other diseases will be assessed on the wild cassowary population. The correlation of infection rates in areas with high human impact and degraded habitat will be investigated. (Latch 2007)

*Questionnaire*

Also in the questionnaire responses more research regarding diseases is recommended.

## 6. Cyclones

*6.1 Indirect threat - literature review*

In the past years several cyclones hit the coast of Mission Beach, destroying even more of the cassowary habitat and resulting in an increase of mortality (Turton 2011). The impact of cyclones on the cassowary population is more severe in small and fragmented areas (Bentrupperbäumer 1998). Cassowaries' natural main food source, fruits, diminished dramatically and therefore cassowaries were forced to leave their natural habitat to forage. Consequently, they approach rural settlements and local farms more often during such periods, especially being attracted to fruit trees. (Moore 2003) Thereby, they face several threats such as road crossings or domestic and roaming dogs (Latch 2007). A shortage of food caused by cyclones weakens the immune system of cassowaries and induces a higher stress level making them prone to diseases (Moore 2008). Due to cyclone 'Larry' in 2006, 18 to 30% of the adult and sub adult cassowary population in Mission Beach died (Rainforest Rescue 2008 and Goosem *et al.* 2011). The actual number of dead cassowaries through starvation and falling debris itself is unidentified. (Goosem *et al.* 2011) Around 50% of the local cassowary population deceased as a result from heat exhaustion and starvation in the 12 months period after the cyclone (Save the Cassowary 2012). In the same period, 14 adults and sub adults died and nearly all dependent chicks vanished (Wormworth & Şekercioğlu 2011). Following cyclone 'Yasi' in 2011, 19 cassowaries died (Rainforest Rescue 2008).

*Questionnaire*

The ranks 2, 4 and 6 are given to cyclones as threat from the experts in the short term. According to these experts, human intervention in the form of feed stations is necessary to support the cassowary survival after cyclones. As direct impact of cyclones a shortage of food resources and competition between birds, especially if chicks are present, is observed. An indirect impact on cassowaries is debris in the destroyed habitat, which often forces cassowaries to move along open routes especially roads exposing them to road accidents.

*6.2 Actions - literature review*

After cyclone 'Yasi' in February 2011, aerial fruit droppings over the rainforest were proceeded to provide food for the cassowaries. The Queensland Government under DERM and QPWS established the Cassowary Response Programme. This programme sets up feed stations to prevent the cassowaries from leaving their natural habitat to forage and to expose them to the danger of getting hit by cars or attacked by dogs. In general they have a positive effect on cassowaries to support them on the short term. A negative aspect is the possible dependence of the cassowaries on these artificial food sources (Bentrupperbäumer 1998). These feed stations are still used, but continuously reduced where cassowaries do not depend on them anymore. In the peak in June 2011, DERM had 105 feed stations which could be reduced to 55 in April 2012. (Queensland Government 2012) Many volunteer groups such as the local nature conservation organizations Foundation for National Parks and Wildlife [FNPW], Rainforest Rescue, Terrain NRM, C4 and Cassowary Coast Regional Council,

supported by the German organization Aktionsgemeinschaft Artenschutz e.V. [AGA], sustain this programme. They also informed the residents about the situation and the effects on the cassowary and started a project of replanting trees to support the redevelopment of the rainforest. (Rainforest Rescue 2008, FNPW 2011 and Queensland Government 2012)

*Questionnaire*

The most important actions on the short term are apparently the post cyclone supplementary feeding programmes, as indicated by the experts. These prevent cassowaries from approaching rural settlements and the risk of road crossing. The participation of inhabitants in setting up feed stations is high to very high and the success medium to high. As a reason for this success, the prompt reaction of management authorities is given. By helping to prepare fruit for the feed stations, the community feels that it is doing something valuable for the cassowaries. The questionnaire revealed that the impact of the feed stations on the cassowary's home range is medium and on their natural behavior and their dependence on the stations is high. The suggested duration of the maintenance time of the feed stations was 1 to 2 years, depending on how well the forest recovers and native fruits become available. Implemented actions such as setting up feed stations are managed pretty well at present but financial support should be made available faster according to the participants.

## 7. Other threats: feral pigs

### *7.1 Direct and indirect - Literature review*

Additionally to these main threats, other threats such as feral pigs exist (Latch 2007). Feral pigs can spread diseases such as tuberculosis, can compete for food with the cassowary and are able to destroy their nests and eat their eggs (Latch 2007). This can have a direct and indirect impact on cassowaries (Mitchell 2000), however until now the impact on the cassowary population is small. (Latch 2007) Illegal shooting of the cassowary can occur while hunting pigs (Crome and Moore 1988, 1990, Moore 1996 a-b, 1999 a-c).

*Questionnaire*

Feral pig was also indicated as additional threat of level 3 in one questionnaire.

### *7.2 Actions - literature review*

The Queensland Department of Natural Resources and Water [DNRW] is involved in feral pig control programmes. The 'Threat Abatement Plan for Pigs' of 2005 was implemented to investigate the impact of feral pigs on cassowaries. Main areas where cassowaries are threatened by the influence of pigs were assessed. The impact of pig involvement and the level of pig control to decrease these negative effects were determined. (Latch 2007) The Cassowary Coast Regional Council and Terrain NRM came up with an exotic species management including feral pigs (Hill *et al.* 2010). In order to approach the problems of pigs, a pig control programme was set up which comprises of pig trapping and hunting. (Bentrupperbäumer 1998 and Werren 1999) According to Moore (2003), pig traps can harm and kill cassowaries. Pig trapping tool boxes with equipment and an accompanying training were distributed for the community to encourage the land owners to set up traps and remove pigs (Latch 2007).

In addition to the pig control programme and pig trapping programme, a post-disaster pig management plan was developed and supported by disaster recovery funding (Turton 2011). New pig control methods should be investigated and further researched (Latch 2007).

*Questionnaire*
Experts recommended continued trapping and shooting feral pigs.

## 8. General Actions

*8.1 Literature review*
QPWS known as the Garner's Beach Cassowary Rehabilitation centre is supported by the 'Hartley's Creek' facility and exists in the Mission Beach area. It is responsible for taking care of any sick, injured or orphaned cassowary. After rehabilitation, cassowaries are successfully translocated and released back into the wild. The translocation of the cassowaries can be quite difficult due to several factors such as the low survival rate in occupied areas, the high expenses and intensive monitoring. (Latch 2007) DERM, local cassowary conservation groups, schools, veterinarians and the Australasian Regional Association of Zoological Parks and Aquaria – Queensland Branch [ARAZPAQ] are involved with the rehabilitation programme. The database from DERM records data on cassowary sightings, sick, injured or dead cassowaries as well as post mortem results and cassowary/human incidents. (Latch 2007)

Several groups, such as Mission Beach Cassowaries, Kuranda Conservation Community Nursery and the Daintree Region Cassowary Group, implemented individual cassowary identification and movement tracking programmes. Thereby DNA scat tests, tourism sightings, Facebook pages and websites and population databases are used. (Terrain NRM 2009)

A population level study is planned to assess the influences of urbanization on cassowaries and human cassowary interactions. For a detailed threat analysis, basic ecological data will be documented with a focus on population ecology, space-use and behavior of cassowaries. In order to be able to determine the exact population number of cassowaries in Queensland a Population Viability Analysis [PVA] is planned. To identify individuals of the cassowary population, DNA identification techniques, individual markings, radio- and satellite-telemetry will be used to provide base-line data on habitat, space used by individuals and the population, population dynamics, social system description, genetic and social mating systems and problem bird ecology. (Latch 2007) DNA identification techniques and radio telemetry are already utilized. (CSIRO 2009 and Campbell 2012) Furthermore, a variety of nature conservation organizations campaign to protect the cassowary through fundraising, post card actions, signature campaigns and cassowary ID projects including an I-phone app tracking system for cassowary sightings. Taylor (2009) indicated that several studies revealed that the most suitable approach to attain cassowary conservation is local area biodiversity planning.

*Questionnaire*
The interest in participating in the rehabilitation centre was indicated as very low, low and high and the success medium to high. The explanation for its achievement is the efficient care,

treatment and release of injured or orphaned cassowaries. The high success rate of released cassowaries back into the wild enhances the positive influence of the rehabilitation centre even though it is run on a low budget.

## 9. General questionnaire

With respect to the success or failure of actions mentioned in the questionnaires, the following observations were made by the experts: lack of dedicated funding, willingness of people to take action and political leadership. The protection of fauna, land and water is divided between different departments and organizations. An additional point of concern is the discrepancy within the community regarding the implementation of strategies.
Another aspect addressed in the questionnaire was the collaboration of different stakeholders involved with the conservation of the cassowary. These are the government, municipality, conservation and scientific organizations, inhabitants and farmers. The cooperation between the various stakeholders is viewed by the experts as mostly poor. In detail between the government and conservation organizations it was indicated as moderate, between municipality and conservation organizations as poor, between conservation organizations as good. Moreover cooperation between scientific organizations and conservation organizations was stated as poor, between government and scientific organizations as moderate and between government, inhabitants and farmers as poor. The participants quoted that finding compromises between their different specific views could improve the cooperation and help to accomplish conclusions. They recognized that the government, municipality, conservation and scientific organizations financially support the protection of the cassowary.

The last point addressed in the questionnaire was the overall attitude of the inhabitants towards the cassowary. According to the experts, most of the inhabitants value the cassowaries as long as they do not approach rural settlements, whereas only few appreciate their appearance in urban areas and support harder restrictions for dogs and fences. Others think it is not necessary at all to worry about the cassowaries. Traffic warning signage and reduced speed limits are apparently not accepted by a majority of people. On the other hand, they fear that the cassowary population in Mission Beach is threatened to decline even more, if the fragmentation of habitat persists exists. An increase of real estate and tourism which leads to more urbanization is expected to decrease the abundance of cassowaries. Opinions such as ‘if the present situation does not get worse, the cassowaries have a chance to survive’ or ‘cassowaries are complicated to manage as the current population numbers are not known’ indicate the diverse appraisal of the situation.

## 10. Overview actions

There are various institutions involved with the planning and implementation of actions to protect the cassowaries in the Mission Beach area. Table 3 shows an overview of these organizations and illustrates which different actions they support. The actions are explained in more detail in the following sections.

**Table 3: Institutions involved in actions**

| Actions | Non-Governmental Organization [NGO] | | | | | | Governmental Organization [GO] | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | AGA* | ARF* | CAG* | FNPW* | Rainforest Rescue | Save the Cass. | Cass. Coast Regional Council | C4* | Terrain NRM* | QLD EPA* | DERM* | QPWS* | QDMR* | WTMA* |
| **Habitat destruction** | x | x | | x | x | x | x | x | x | x | x | | | |
| **Road kills** | | x | | | | | | x | | x | x | x | x | |
| **Dog attacks** | | x | x | | | | | | | x | x | x | | x |
| **Hand feeding** | | x | x | | | | | | | x | | | | x |
| **Disease** | | | | | | | | | | | x | x | | |
| **Cyclone** | x | | | x | x | | x | x | x | | x | x | | |
| **Feral pigs** | | x | | | | | x | | x | | | x | | |

* Abbreviations:
[ARF] Australian Rainforest Foundation; [CAG] Cassowary Advisory Group; [C4] Community for Costal and Cassowary Conservation; [Terrain NRM] Terrain Natural Resource Management; [QLD EPA] Queensland Environmental Protection Agency; [DERM] Department of Environment and Resource Management; [QPWS] Queensland Parks and Wildlife Service; [QDMR] Queensland Department of Main Roads; [WTMA] Wet Tropics Management Authority; [AGA] Aktionsgemeinschaft Artenschutz e.V.; [FNPW] Foundation for National Parks and Wildlife and [DNRW] Queensland Department of Natural Resources and Water

The following parties are involved with general actions:

- ARF
- C4
- DERM
- Australasian Regional Association of Zoological Parks and Aquaria - Queensland Branch [ARAZPAQ]
- Garners Beach Cassowary Rehabilitation Centre
- Schools
- Veterinarians
- Mission Beach Cassowaries
- Kuranda Conservation Community Nursery
- Daintree Region Cassowary Group
- The Commonwealth Scientific and Industrial Research Organization [CSIRO]

## *Discussion and conclusion*

This systematic review of the current literature on the cassowary population in Mission Beach, Queensland, Australia, which is complemented by a limited number of answers from local experts to a questionnaire, reveals a remarkable general observation: Despite the well accepted fact that the unique population of the Mission Beach cassowaries is endangered and is one of the priority biodiversity hot spots in Northern Queensland, systematic and detailed research on population numbers and cassowary habitat is apparently still missing. Based on available recent numbers of the cassowary population, considering their slow reproduction rate and in view of the statements given in the questionnaires, a continuing decline of the cassowary population appears likely. The experts, who were surveyed with the questionnaire, remarked an insufficient availability of information leading to only partially completed responses. This impression seems to underline the lack of sufficient data regarding habitat loss, mortality rate and population numbers in the available literature. As the number of detailed information given in the returned questionnaires was very small, no statistical data

analysis could be performed. It should be kept in mind that statements cited from these questionnaires reflect mostly expert opinions. However, such opinions indicate the current awareness on site and furthermore underline the problems with the acceptance of various actions to reduce threats and protect the cassowaries. Although certain discussed actions are not quite suitable for the cassowaries or can even have a negative effect, such as fences, culverts, wildlife detectors and feed stations, these actions have not been adapted yet (Chenoweth 2008). At present there is only the 'Be Cass-O-Wary Programme' which aims to influence the attitude of people visiting or living in the area, even though the involvement and understanding of the inhabitants in such protective actions certainly play the most important role in the future conservation of the cassowary.

In literature, a fairly large variation in the data on population numbers and fatalities due to the various threats is published. In addition, no regular or annual population analysis over the last 10-20 years has been conducted or published. Therefore, from the available reports it is difficult to generate a scientifically sound picture of the past and possible future development of this specific cassowary population. The same problems exist with respect to an exact documentation of the main threats, habitat loss due to human influences or the cyclones on the one hand and on the other hand of the area of remaining suitable and intact habitat. Notwithstanding the fact that, according to literature and opinions of the experts, habitat destruction and an increasing number of roads and traffic cause the main threat to the cassowaries in Mission Beach area, habitat destruction still continues. This occurs although Mission Beach area is situated in a World Heritage area. (Latch 2007) This situation is most likely caused by conflicting interests between conservation organizations, tourism and real estate industries as also stated by one of the experts. This trend seems to persist despite efforts induced by the Tully-Mission Beach road management strategies, which were implemented and used as a model project. This may be partly due to the fact that this plan is not yet fully realized. Despite the existing research on the speed reduction from 80 to 60 km/h on other animals in other areas, such as the koala, which showed a successful decrease in road incidents, the speed limit remains 80 km/h on most roads in the Mission Beach area. (Chenoweth 2008) As only incomplete and irregular data of road kills exist in literature, it is impossible to display a trend based on these data. These literature data suggest that mortality rates due to road accidents with cassowaries are slightly higher after cyclones. It is known that cassowaries increasingly enter human settlements and cross roads when food availability is reduced after a cyclone. However, a database maintained by QPWS and DEHP with annual recorded deaths on roads of cassowaries exists, which does not reflect such a correlation between numbers of deaths on roads and cyclones. The reliability of both data, in the literature and in the above cited database, with respect to the amount of registered cassowary deaths appears questionable due to the fact that not all cassowary deaths are reported.

### *Recommendations*

The lack of exact data on the cassowary population and their development, especially after implementation of protective actions, and the exact documentation of the impacts of these actions, make it difficult to overview their success at present and draw conclusions for further improvements. Therefore, it appears essential that more and detailed research in the Mission Beach area on life history traits, population numbers, genetics and identification of individuals as well as on mitigation strategies to prevent cassowary mortality is conducted. This includes already implemented actions such as decrease of road incidents and injuries through pig traps. Such an explicit research and further improvement of strategies as partly already suggested by several authors will lead to a better understanding of the cassowary and help to optimize its management to assure a long term survival of this endangered species.
To be able to draw a scientific and profound conclusion regarding the threats to the cassowary and to choose the most effective actions considering the limited financial resources, precise census of habitat destruction, population numbers and the success of implemented strategies is vital. An overview on these specific recommendations is given in table 4, which illustrates how threats can be better assessed and actions can be adjusted and improved.

**Table 4: Overview on specific recommendations**

| | **Recommendations Threats** | **Recommendations Actions** |
|---|---|---|
| **Habitat destruction** | Identify destructed and remaining cassowary habitat and corridors | Develop strategy for cassowary habitat protection on private land;<br>continue tree planting and buy back of land for corridors |
| **Road kills** | Continue maintaining database of recorded road kills | Use more overpasses & improve fences or use earth mounds instead;<br>obligate reduced speed limit (60km/h) on more roads; improve Tully-Mission Beach Road<br>Model and implement in more areas; in general more research on implemented strategies |
| **Dog attacks** | Continue maintaining database of recorded dog attacks | Find compromises for dog owners and protection of cassowaries |
| **Hand feeding** | - | Stricter regulations and more prohibition signs |
| **Disease** | Continue maintaining database of diseased cassowaries | More genetic research to get deeper knowledge about diseases |
| **Cyclone** | Continue maintaining database on cassowary deaths | Maintain feed stations only if necessary; use wild fruits or deseed fruits |
| **Feral pigs** | - | Design a different trap and prohibit shooting of cassowaries. Research on new pig control methods. |
| **General** | Improve collaboration between stakeholders and exchange of data<br><br>Develop and enhance 'Be Cass-O-Wary Programme' | Better cooperation and communication amongst the stakeholders to assure a successful implementation of actions.<br>More focus on attitude and habits of inhabitants (e.g. buy back of property, speed limit, dog attacks, hand feeding) |

In the authors view according to the outcome of this literature study, the best opportunities for AGA to fund actions of their partner organization FNPW, carried out from Germany, are the further support of the tree plant and feed station actions to overcome the restrictions in food availability. Furthermore, the promotion of new aspects such as specific research, buy back corridor campaigns and programmes to change the attitude of the inhabitants towards the cassowary.

## *Zusammenfassung*

Der Helmkasuar (*Casuarius casuarius johnsonii*) ist eine gefährdete Tierart in Queensland, im Norden Australiens. Eine Literaturuntersuchung über die Kasuarpopulation in Mission Beach wurde durchgeführt, um die verschiedenen Gefahren, die den Kasuar bedrohen, zu identifizieren. Dabei wurde festgestellt, dass eine Anzahl von Recherchen die Bedrohungen bereits aufzeigen. Verschiedene Aktionen, um diesen Gefährdungen entgegenzuwirken, wurden empfohlen und teilweise implementiert zum Schutz dieser Art. Die problematische Situation für die Kasuare wird durch die Vielzahl involvierter Institutionen, die sich für den Erhalt des Kasuars einsetzen, betont. Eine zusätzlich ausgeführte Umfrage verdeutlicht die Situation und spiegelt die Meinung der Experten vor Ort wieder. Laut Literatur und Experten, bilden der kontinuierliche Verlust und die Fragmentierung des Habitats die Hauptbedrohung, wobei Unfälle auf Straßen die höchste Todesrate verursachen. Ein bemerkenswerter Befund ist die Ungenauigkeit und Unregelmäßigkeit in der Erfassung der exakten Populationsgröße und des restlichen Kasuarhabitats in Mission Beach und Umgebung. Trotz bereits ausgeführter Artenschutzaktionen nimmt die Population stetig weiter ab. Deshalb ist eine Überprüfung und gegebenenfalls Verbesserung von geplanten und implementierten Aktionen von Bedeutung. Mehr detaillierte Forschung und Dokumentation sind nötig, um die genaue Kasuarpopulation und das verbliebene Habitat und den Einfluss der verschiedenen Bedrohungen bestimmen zu können. Dies ermöglicht eine erfolgreiche Ausführung von Aktionen zur Erhaltung des Kasuars.

## *Acknowledgments*

We would like to thank Birgit Braun from Aktionsgemeinschaft Artenschutz e.V. [AGA] for giving us the opportunity to write this article for AGA. The supervision of Birgit Braun and our lecturers Berend van Wijk and Jelmer van Belle are very much appreciated. Moreover, we thank Liz Gallie for all her input and all Australian experts who supported us with their participation, knowledge and involvement. We are grateful for the insightful observations and support from our families and friends, especially our parents.

## *References*

ARF (2012) Australian Rainforest Foundation 'Operation Big Bird-Save the cassowary.' Available from: http://www.arf.net.au/content.php?pageid=1280810987&getsubnavid=1280380330 (accessed: 18 June, 2012)

Barker, R.D. and W.J.M. Vestjens (1989) 'The Food of Australian Birds. 1 Non-Passerines.' Lyneham, ACT: CSIRO

Bentrupperbäumer, J.M. (1998) 'Reciprocal ecosystem impact and behavioural interactions between cassowaries, Casuarius casuarius, and humans, Homo sapiens, exploring the natural-human environment interface and its implications for endangered species recovery.' Ph.D. Thesis. Townsville: James Cook University of North Queensland.

Bentrupperbäumer, J. and Goosem, M. (2005) Design of cassowary fencing. Advice to Queensland Department of Main Roads.

Bradford, M.G. and Westcott, D.A. (2010) 'Consequence of southern cassowary (*Casuarius casuarius,* L.) gut passage and deposition pattern aon the germination of rainforest seeds', Austral Ecology 35, 325-333

Buosi, P. and S. Burnett (2006) 'The Southern Cassowary (Casuarius casuarius johnsonii): Review of Values and Threats in the Wet Tropics Bioregion, Queensland.' A report for DEH. Queensland: Natural Resources Assessments Environmental Consultants

CAFNEC (2012) The Cairns and Far North Environment Centre Inc. Available from: http://www.cafnec.org.au/campaigns/cassowaries.php (accessed: 21 May 2012)

Campbell, H., Dwyer, R., Fitzgibbons, S., Klein, C., Lauridsen, G., McKeown, A., Olsson, A., Sullivan, S., Watts, M., and Westcott, D. (2012) 'Prioritising the protection of habitat utilised by southern cassowaries *Casuarius casuarius johnsonii.'* Endangered Species Research. Vol. 17: 53–61

Cassowary Coast Regional Council (2012) Available from: http://www.cassowarycoast.qld.gov.au/web/guest/home (accessed: 17 June, 2012)

Chenoweth (2008) Chenoweth Environmental Planning and Landscape Architecture 'Wongaling Corridors Fauna Crossing.' Brisbane, Australia

C4 (2010) Community for Coastal and Cassowary Conservation 'New Bulletin No 154'. Available from: http://www.cassowaryconservation.asn.au/Newbulletin/1542010060708.pdf (accessed: 10 June, 2012)

Crome, F.H.J. & Bentrupperbäumer J. (1991) 'Management of Cassowaries in the fragmented rainforests of north Queensland.' Unpublished report to the Endangered Species Programme of the Australian National Parks and Wildlife Service.

Crome, F.H.K. and Bentrupperbäumer J. (1992) 'Cassowaries in north Queensland II. Fieldwork in 1992. A consultancy report to The Endangered Species Program of the Australian National Parks and Wildlife Service

Crome, F.H.J. and Moore, L.A. (1988) 'The Southern Cassowary in North Queensland – a pilot study.' Vols I-IV . Unpublished report prepared for the Queensland National Parks and Wildlife Service and the Australian National Parks and Wildlife Service.

Crome, F.H.J. & L.A. Moore (1990). Cassowaries in north-eastern Queensland: report of a survey and a review and assessment of their status and conservation and management needs. Australian Wildlife Research. 17:369-385

CSIRO (2009) The Commonwealth Scientific and Industrial Research Organization. Available from: http://www.csiro.au/Organisation-Structure/Divisions/Ecosystem-Sciences/DNA-technique-for-Cassowaries.aspx (accessed 17 June, 2012)

FNPW (2011) Foundation For National Parks and Wildlife. Available from: http://fnpw.org.au/plants-a-wildlife/birds/cassowary/cassowary-corridor-mission-beach (accessed: 2 June, 2012)

Garnett, S. and Crowley, G. (2000) 'The Action Plan for Australian Birds 2000.' Environment Australia, Canberra

Goosem, S. (1992) Draft Management Plan Mission Beach Area, North Queensland. Queensland Department of Environment and Heritage Report, Far Northern Region, Cairns

Goosem, M., Moore, L. A., Byrnes, P. and Gibson, M. (2011) *Mission Beach Road Research: Impacts on Cassowaries and other Fauna and Strategies for Mitigation.* School of Earth and Environmental Science, James Cook University, Cairns. (298 pp.)

Grummt, W. and Strehlow, H. (2009), *'Zootierhaltung, Tiere in menschlicher Obhut, Vögel'* Harri Deutsch, Frankfurt am Main

Hill, R., Williams K.J., Pert, P.L., Grace, R., O'Malley, T. and S. Jenkins (2010) 'Mission Beach Habitat Network Action Plan' CSIRO and Terrain NRM, Cairns.

IUCN (2011), IUCN Red List of Threatened Species. Version 2011.2. Available from: www.iucnredlist.org (accessed: 17 March, 2012)

Kofron, C.P. (1999) 'Attacks to humans and domestic animals by the southern cassowary (Casuarius casuarius johnsonii) in Queensland, Australia', Journal of Zoology

Kofron, C.P. and Chapman, A. (2006) 'Causes of mortality to the endangered Southern Cassowary (*Casuarius casuaris johnsonii*) in Queensland, Australia', Pacific Conservation Biology

Latch, P., (2007) 'Recovery plan for the southern cassowary *Casuarius casuarius johnsonii'.* Cassowary Recovery Team

Laurence, W. F. and Curran, T.J. (2008) 'Impacts of wind disturbance on fragmented tropical forests: A review and synthesis', Australian Ecology 33, 399-408

Marchant, S. and P.J. Higgins, eds. (1990). 'Handbook of Australian, New Zealand and Antarctic Birds. Volume One - Ratites to Ducks.' Melbourne, Victoria: Oxford University Press.

Mission Beach Cassowaries (2010) Available from: http://www.missionbeachcassowaries.com/cassowary1.html (accessed: 21 May, 2012)

Mitchell, J. (2000) 'Ecology and Management of Feral Pigs in Tropical Rainforest' PhD Thesis. James Cook University of North Queensland, Townsville.

Moore, L.A. (1996a) 'Cassowary Monitoring Program in the Daintree to Cape Tribulation Area, Stage 1, 15-27 July 1996.' A report to Wet Tropics Management Authority

Moore, L.A. (1996b) 'Cassowary Monitoring Program in the Daintree to Cape Tribulation Area, Stage 2, 27 November – 8 December 1996.' A report to Wet Tropics Management Authority

Moore, L.A. (1998a) 'Cassowary Conservation Roads: A Cassowary Management Strategy and Road Upgrade Assessment for El Arish and Tully-Mission Beach Roads, Mission Beach.' Report for Queensland Department of Main Roads

Moore, L.A. (1998b) 'Field survey of cassowaries in the Kuranda region (Cairns).' Report for Wet Tropics Management Authority

Moore, L.A. (1998c) 'Draft Cassowary Management Plan for Daintree lowlands bioregion.' Report for Wet Tropics Management Authority

Moore, L.A. (1998d) 'Stage 1. Dry Season Fauna Survey and Envrionmental Impact Assessment of Proposed Road Re-alignment – East Evelyn and Sluice Creek Roads, Atherton Tablelands, north Queensland.' Report for Queensland Department of Main Roads

Moore, L.A. (1999a) 'Road Link Study-Southern Atherton Tablelands: A field survey to assess the major issues of road upgrades on selected Rare and Endangered fauna.' Report for Queensland Department of Main Roads

Moore L.A. (1999b) 'Road Crossing Points and Management Strategies for Street Creek Cassowary #11.' A Report for the Wet Tropics Management Authority

Moore, L.A. (1999c) 'Cassowary Road Crossing Strategy: Buchanan Creek Road, Daintree Lowlands.' A Report for the Wet Tropics Management Authority

Moore, L.A. (2000a) 'Surveying and Endangered Rainforest Species: Methods and Application. The Southern Cassowary *Casuarius casuarius johnsonii.'* Masters of Science Thesis (Preliminary), James Cook University, Townsville, Australia

Moore, L.A. (2000b) 'Literature survey, bibliography and museum specimen lists for the Southern Cassowary *Casuarius casuarius johnsonii.*' Supplement to Masters of Science Thesis (Preliminary), James Cook University, Townsville, Australia

Moore, L.A. (2003) 'Ecology and population viability analysis of the southern cassowary, Causarius casuarius johnsonii, Mission Beach, north Queensland.' Page(s) 202. M.Sc. Thesis. Townsville: James Cook University

Moore, L.A. (2007) 'Population ecology of the southern cassowary *Casuaris casuaris johnsonii*, Mission Beach north Queensland' *Journal of Ornithology* 148: 357-366

Moore, L. (2008) Cassowaries still feeling cyclone pain. ABC News In Science Online Report published 21/02/2008

Moore, L.A. and Moore, N.J. (1999) Cassowary management project for the Wet Tropics Management Authority. 1. Interim report of the Kuranda field survey (November – December, 1998). 2. Streets Creek cassowary 1, road crossing points and management strategies. Report to the Wet Tropics Management Authority, Cairns, Australia.

Moore, L.A. and Moore, N. J. Pty. Ltd. (2001) 'The Cassowaries of Mission Beach.' Report to the Wet Tropics Management Authority

MTSRF (2009) Marine and Tropical Sciences Research Facility, Reef and Rainforest Research Centre 'Marine and Tropical Sciences Research Facility Milestone Report, November 2009'

QDMR (2001) Queensland Department of Main Roads. 'Cassowary Management Strategy- Tully-Mission Beach Road'

QPWS (2003) Queensland Parks and Wildlife Service 'The status of cassowaries on Cape York Peninsula.' Unpublished Report to CY NHT, Department of Environment and Heritage

Queensland Government (2012) Environment and Resource Management. Available from: http://www.derm.qld.gov.au/wildlife-ecosystems/wildlife/threatened_plants_and_animals/endangered/cassowary-tc-yasi.html (accessed: 21 May, 2012)

Rainforest Rescue (2008), Protect Rainforests Forever. Available from: http://www.rainforestrescue.org.au/ourprojects/save-a-rainforest-mission-beach.html (accessed: 27 March, 2012)

Save the Cassowary (2012) Available from: http://www.savethecassowary.org.au/mission-beach (accessed: 14 March, 2012)

Taylor, R. (2009) 'Lessons From Cyclone Larry' ECOS, CSIRO Publishing, Collingwood, Australia

Terrain NRM (2009) Terrain Natural Resource Management. Available from: http://www.terrain.nl.org.au (accessed: 25 March, 2012)

Turton, S.M. (2011) 'Securing Landscape Resilience to Tropical Cyclones in Australia's Wet Tropics under a Changing Climate: Lessons from Cyclones Larry (and Yasi)'. Centre for Tropical Environmental and Sustainability Sciences, School of Earth and Environmental Sciences, James Cook University, Cairns, Qld 4870, Australia.

Werren, G.L. (1999) 'Cassowary Surveys of the Tully and Cowley Beach Training areas, North Queensland.' Australian Centre for Tropical Freshwater Research, James Cook University, Cairns, Australia

Westcott, D.A. and Reid, K. (2002) 'Use of medetomidine for capture and restraint of *cassowaries (Casuarius casuarius*). '*Australian Veterinary Journal* 80:150–3.

Westcott, D.A., Bentrupperbäumer, J., Bradford, M.G. and McKeown, A. (2005) 'Incorporating patterns of disperser behavior into models of seed dispersal and its effects on estimated dispersal curves.' *Oecologia* 146: 57–67

Wet Tropics (2010) Wet Tropics Management Authority. Available from: http://www.wettropics.gov.au/pa/pa_casso.html (accessed: 21 May 2012)

Wormworth, J., and Şekercioğlu, C.H. (2011) '*Winged Sentinels: Birds and Climate Change*' Cambridge University Press, Melbourne, Australia

Teresia R. S. Robitschko, Department of Wildlife Management at Van Hall Larenstein, University of Applied Science, the Netherlands, teresiarobitschko@yahoo.de

Meike Schlatter, Department of Wildlife Management at Van Hall Larenstein, University of Applied Science, the Netherlands, meike.schlatter@web.de

*Appendix Questionnaire*

# Questionnaire about Southern cassowary population in Mission Beach

This questionnaire is conducted within the final thesis of Meike Schlatter and Teresia Robitschko for the study of Wildlife Management at Van Hall Larenstein, University of Applied Sciences, the Netherlands. The thesis '*The Southern cassowary (Casuarius casuarius johnsonii) population in Mission Beach, Northern Australia: Threats and protective actions'* is written for the German Conservation organization 'Aktionsgemeinschaft Artenschutz' (AGA). The aim of the thesis is to assess the threats and suggested and implemented protective actions for the cassowary population in Mission Beach, Queensland, Australia based on a literature review and a survey among local experts.
A prioritization of these threats has been attempted in some publications, but it appears uncertain which exact impact they have on the population. Which actions are suggested and implemented and what are their results? How did the situation change for the cassowary population and how is the outlook for future developments of this population? In publications and reports some answers to these questions can be found, but a comprehensive view on situation today is difficult to obtain.

If you are not in the position to answer a question, please leave it open.
Please return this questionnaire via mail until the 1st of June 2012 to Meike.Schlatter@wur.nl.
To fill in this questionnaire will take approximately about 30 minutes.

Thank you very much for your time and effort to fill in this questionnaire.

---

## I. Personal Information about the respondent

*(Important: we guarantee that this personal information will just be used for our own evaluation and will not be included in any report or publication. There will not be any reference from your answers given to sections II to VI to this personal information.)*

Date

Name

Professional background

Organization

Position

How long have you been involved with the conservation of the Southern cassowary?

years or months

---

## II. Biological data on the Southern cassowary population Mission Beach

1. What is the present known estimated number of cassowaries in Mission Beach?

| | Females | Males | Sex unknown |
|---|---|---|---|
| Adults (>= 3 years) | | | |
| Sub adults (9-36 months) | | | |
| Chicks (< 9 months) | | | |

## III. Threats to the cassowary population in Mission Beach

1. According to scientific papers there are several main threats to the cassowary population in Mission Beach. What is your personal evaluation and opinion of the main threats on the short (1 year)/ long term (>3-5 years)? *Please indicate the main to least threat (1 indicating the highest).*

| | 1 | 2 | 3 | 4 | 5 | 6 | Short term | Long Term |
|---|---|---|---|---|---|---|---|---|
| Habitat destruction* | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Road accidents | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Dog attacks | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Hand feeding | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Diseases | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Cyclones | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Other ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Other ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Other ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

* Habitat destruction includes habitat loss, fragmentation and degradation

2. Please indicate the habitat loss of the cassowary habitat in Mission Beach as far as you are able to do so. Please specify another time frame if information on last 15 years is not available.

| | Total area (km²) | | Relative area (%) | |
|---|---|---|---|---|
| | last 15 years | 2011-2012 | last 15 years | 2011-2012 |
| Habitat loss | ☐ | ☐ | ☐ | ☐ |
| | ☐ months ☐ years | | ☐ months ☐ years | |

3. Please give mortality numbers (total and percentages of the following threats of the last 15 years and for the last year if possible (*a. = adults (>= 3 years) s.a. = sub adults (9-36 months) ch. = chicks (< 9 months)). Please indicate another time frame if information on last 15 years is not available (m = months and y = years).

| | Mortality numbers (total) | | | | | | | | Mortality numbers (%) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | last 15 years | | | | 2011-2012 | | | | Last 15 years | | | | 2011-2012 | | | |
| | *a. | s.a. | ch. | all | a. | s.a. | ch. | all | a. | s.a. | ch. | all | a. | s.a. | ch. | all |
| Road accidents | | | | | | | | | | | | | | | | |
| | m | | y | | | | | | m | | y | | | | | |
| Dog attacks | | | | | | | | | | | | | | | | |
| | m | | y | | | | | | m | | y | | | | | |
| Diseases | | | | | | | | | | | | | | | | |
| | m | | y | | | | | | m | | y | | | | | |
| Cyclones | | | | | | | | | | | | | | | | |
| | m | | y | | | | | | m | | y | | | | | |
| Other | | | | | | | | | | | | | | | | |
| | m | | y | | | | | | m | | y | | | | | |
| Other | | | | | | | | | | | | | | | | |
| | m | | y | | | | | | m | | y | | | | | |
| Other | | | | | | | | | | | | | | | | |
| | m | | y | | | | | | m | | y | | | | | |

4. Please indicate the main kind of vehicle (e.g. car, truck, bus)

   and the main road accidents perpetrators (e.g. locals, tourists).

5. Which dogs are causing a higher mortality of the cassowary?

   Domestic dogs ☐ Roaming dogs ☐

6. What is the most common deadly disease of the cassowary?

7. What kind of lethal impacts do cyclones have on the cassowaries?

Direct lethal impact

Indirect lethal impact

---

## IV. Planned and implemented actions for the protection of the cassowary in Mission Beach

1. Please explain which protection action(s) appear the most important to you on the short and the long term?

short term

long term

2. How is the interest of the local people to participate on the following actions?

| | very high | high | medium | low | very low | no interest |
|---|---|---|---|---|---|---|
| Tree planting | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Re-buy of land | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Corridor | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Speed reduction | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| 'Be Cass-O-Wary' (program for dog and hand feeding issues) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Rehabilitation center | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Set up feed stations | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Other | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Other | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Other | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

3. How successful is the implementation of these actions? Please indicate why.

| | high | medium | low | why |
|---|---|---|---|---|
| Tree planting | ☐ | ☐ | ☐ | |
| Re-buy of land | ☐ | ☐ | ☐ | |
| Corridor | ☐ | ☐ | ☐ | |
| Speed reduction | ☐ | ☐ | ☐ | |
| 'Be Cass-O-Wary' (program for dog and hand feeding issues) | ☐ | ☐ | ☐ | |
| Rehabilitation center | ☐ | ☐ | ☐ | |
| Set up feed stations | ☐ | ☐ | ☐ | |
| Other | ☐ | ☐ | ☐ | |
| Other | ☐ | ☐ | ☐ | |
| Other | ☐ | ☐ | ☐ | |

4. What are the main problems and obstacles occurring in Mission Beach when implementing the actions mentioned in question 3? Please indicate them in prioritized order.

5. What impact do the set up feed stations have on the cassowarys'

| | very high | high | medium | low | very low | no impact |
|---|---|---|---|---|---|---|
| Natural behavior | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Home range | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Dependence on the stations | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Other | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Other | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| Other | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

6. For how long do the feed stations have to be maintained to be effective?

months years

7. Please give recommendations concerning suggested/implemented actions for the threats

1. Habitat destruction

2. Road accidents

3. Dog attacks

4. Hand feeding

5. Diseases

6. Natural catastrophes: cyclones

7. Other

8. Other

9. Other

## V: Stakeholders involved with the cassowary population in Mission Beach

1. Which different stakeholders cooperate with each other in the protection of the cassowaries? Please rate the cooperation as follows: **G** for good, **M** for moderate, **P** for poor and **N** for none existing.

| | Government | Municipality | Conservation organizations | Scientific organizations | Locals | Farmers | Tourists | Other | Other | Other |
|---|---|---|---|---|---|---|---|---|---|---|
| Government | x | | | | | | | | | |
| Municipality | | x | | | | | | | | |
| Conservation organizations | | | x | | | | | | | |
| Scientific organizations | | | | x | | | | | | |
| Locals | | | | | x | | | | | |
| Farmers | | | | | | x | | | | |
| Tourists | | | | | | | x | | | |
| Other | | | | | | | | x | | |
| Other | | | | | | | | | x | |
| Other | | | | | | | | | | x |

2. What could be improved in the cooperation between the different stakeholders in your opinion?

3. Which stakeholders support the protection of the cassowaries financially?

- Government ☐
- Municipality ☐
- Conservation organizations ☐
- Scientific organizations ☐
- Locals ☐
- Farmers ☐
- Tourists ☐
- Other ☐
- Other ☐
- Other ☐

4. How is the general (basic or most common) attitude of the locals towards the situation of the cassowary in Mission Beach?

---

## VI: Future development and predictions for the cassowary population in Mission Beach

1. What actions or research have not been contemplated on the cassowary yet and which aspects should be further developed in your opinion?

2. What are your future expectations for the development of the cassowary population in Mission Beach?

3. Please feel free to express any further remarks which are relevant for this study.

**Thank you very much once more for participating in this questionnaire!**

I would like to obtain a PDF-copy of your final thesis paper via e-mail ☐

My e-mail address is: