Study on the two cuscus species in the Manusela NP on Seram Island, Indonesia – densities, species preferences and hunting

Studie über die zwei Kuskusarten im Manusela Nationalpark auf der Insel Seram, Indonesien – Dichte, Präferenzen der Arten und Bejagung

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Abstract

A study was done about the two cuscus species that occur on Seram Island, Maluku, Indonesia: The Northern Common Cuscus (*Phalanger orientalis*) and the Common Spotted Cuscus (*Spilocuscus maculatus*). Data was collected throughout 2 months during transect walks, using the spotlight method and through interviews held with local hunters. Data on densities, a comparison preference of habitat and time of activity and local hunting patterns, with a special focus on the cuscus and hunting inside the National Park, are presented. The results show quite clearly that the two cuscus species are active at different times and that the Northern Common Cuscus can be found more in higher altitudes than the Common Spotted Cuscus. Densitiy estimates were lower for the Spotted Cuscus than for the Northern Cuscus, although this might be due to a very low number of observations for the Spotted Cuscus, so that the estimates might be incorrect.

Interviews showed that the cuscus does play a role as a hunted species, however it seems slightly less important than deer and wild pig. Hunting does occur inside the National Park, even though it is mostly practiced with traditional hunting methods and even if not allowed, at least accepted by National Park Officials.

Zusammenfassung

Es wurde eine Studie über die zwei Kuskusarten, welche auf der Insel Seram, Maluku, Indonesien vorkommen, gemacht: Den Wollkuskus (*Phalanger orientalis*) und den Tüpfelkuskus (*Spilocuscus maculatus*). Daten wurden über zwei Monate während Transektbegehungen, auf denen die Spotlight-Methode angewandt wurde, gesammelt und durch Interviews, welche mit den ansässigen Jägern abgehalten wurden. Daten über Dichte, ein Vergleich der Habitatspräferenz und bevorzugte Tagesaktivität und regionale Jagdmuster, mit einem Schwerpunkt auf Kuskus und Jagd im Nationalpark, werden dargestellt. Die Ergebnisse zeigen ziemlich deutlich, dass die zwei Kuskusarten zu unterschiedlichen Tageszeiten aktiv sind und dass der Wollkuskus eher in höheren Lagen anzutreffen ist, als der Tüpfelkuskus. Dichteschätzungen waren für den Tüpfelkukus niedriger als für den Wollkuskus, was allerdings aufgrund einer geringen Nummer an Sichtungen des Tüpfelkuskus liegen kann, welche zur Folge haben kann, dass die Dichte falsch geschätzt wird.

Interviews zeigten, dass der Kuskus eine Rolle als bejagte Art spielt, allerdings scheint er etwas weniger wichtig zu sein als Hirsch und Wildschwein. Im Nationalpark wird auch gejagt, allerdings hauptsächlich mit traditionellen Jagdmethoden und auch wenn es auch nicht offiziell erlaubt ist, wird dies zumindest von Seiten der Nationalparkangestellten akzeptiert.

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1 Introduction

1.1 Study objectives

In terms of species numbers and endemism, the biodiversity of Indonesia is ranked second highest in the world right after Brasil. This is partly due to the Wallacea line, which is a transition zone that runs between two major biogeographic regions: Australasia and Indio-Malaya. This zone has a very unique complement of flora and fauna (BAINES and HENDRO 2002).

The wide range of ecosystems that Indonesia supports, play a crucial role in the provision of livelihoods and environmental services. More than 6,000 species of plants and animals are used for food, medicines, building and other uses and it is estimated that more than 40 million people in Indonesia are directly dependent on biodiversity for subsistence (BAINES and HENDRO 2002).

However, there are pressures like hunting, loss and degradation of natural habitats and wildlife trade, that threaten this biodiversity (LEE et al., 2001). Often these threats are not adequately addressed because of weak conservation laws and poor management of protected areas (LEE et al., 2001). A further restraint to deal with these threats is the lack of information about ecosystems, landscapes and species (RILEY, 2002).

One major threat to biodiversity in tropical forests is the unsustainable hunting of wildlife (ROBINSON and BODMER,1999). In the humid tropics humans have been hunting wildlife for 100 000 years but the consumption has increased over the past few decades and today wild meat is consumed on an extensive scale (MILLNER-GULLAND and BENNETT, 2003).

This is due to a combination of factors with increasing human populations and changes in the method of hunting being two main reasons (BENNETT and ROBINSON, 2000). Studies have been done in South America, Africa and Asia but studies from Australasia and Melanesia are only very few or lacking all together (CUTHBERT, 2010). Additionally information about species in this region is lacking (CUTHBERT, 2010) making conservation efforts even more difficult.

In the Maluku province, a group of about 1000 islands of estern Indonesia, cuscuses make up quite an important part of the mammal fauna (MACDONALD et al. 1993; FLANNERY, 1997) and therefore also play a role in the diet of people (LATINIS, 1996; SASAOKA, 2002).

However, only very limited information exists about the cuscuses of this region and mostly on endemic species that occur on some islands. The densities and numbers are largely unknown as is the importance of the species for the local people.

This study took place on Seram island, the second largest island of the Maluku province, with the following objectives:

- To provide some baseline data about the densities of the two cuscus species that occur on Seram island since no studies have been carried out on this aspect yet.
- Comparing the preferences of the two different species that occur on Seram island, in terms of time of activity and habitat.
- To provide data about the hunting practices of the local people through a case study in Mashiulan village and to identify the kinds of animals predominately hunted and describe the hunting methods used, with a special focus on cuscuses in the Manusela NP.

1.2 The Cuscus

Cuscuses are arboreal marsupials, that belong to the subclass of Marsupialia, the order of Diprotodontia and to the family of Phalangerida and are divided into the four genera *Ailurops, Phalanger, Spilocuscus* and *Strigocusucus* (MCNAB, 2008).
They feed on leaves, fruits, flowers, bark, and sometimes insects and meat (LATINIS, 1996). It is possible that there are differences in food habits of cuscuses that vary among species but few field studies have clarified these, should they exist. High-altitude species, for example, may feed more on foliage than do low-altitude species due to reduced presence of fruits at high altitudes (MCNAB, 2008). Marsupials give birth to poorly devloped young that continue their development inside the female’s pouch which is called marsupium and after which this group of mammals is named (MACDONALD et al., 1993).
There are two cuscus species that occur on Seram island (MACDONALD et al.1993; FLANNERY 1997) and which are of interest to this study: The Northern the Common

Spotted Cuscus (*Spilocuscus maculatus*, Geoffroy, E.,1803). These may well have been introduced from New Guinea, and may have replaced endemic species. (FLANNERY, 1997; HELGEN et al. 2004). Both species are listed as least concern on the IUCN Red List and are CITES Appendix II species.

The local people sometimes seem to recognise more than two species but this is probably due to sexual and developmental dimorphism in coat colour (MACDONALD et al. 1993). Both species are taken for food by the local people (MACDONALD et al. 1993; LATINIS, 1996).

1.2.1 Common Spotted Cuscus (*Spilocuscus maculatus*)

Distribution

This species is native to Australia, Indonesia and Papua New Guinea. It is found through much of the southern Moluccan Islands, including Buru, Seram, Banda, and Ambon; it is present on the islands of Misool and Yapen, the Kai Islands and the Aru Islands; it is distributed over much of the island of New Guinea; and is present on the Cape York Peninsula, Australia. It has been introduced to the islands of Mussau and New Ireland, and to Salayer Island, south of Sulawesi. Its altitudinal range of sea level is up to 1,400 m asl. (LEARY et al. 2008) Common Cuscus or Grey Cuscus (*Phalanger orientalis*, Pallas, 1766. Revised by Menzies and Pernetta, 1986).

Description

The spotted cuscuses are a group of colorful, medium sized, arboreal frugivore-folivores endemic to tropical forests in the Australo-Papuan region (HELGEN and FLANNERY, 2004). It is found in primary and secondary tropical moist forest. It has also been recorded in mangrove forest (LEARY et al., 2008). The female is thought to carry one single young only (MACDONALD, 1993; WINTER and LEUNG 1995). Among phalangerid genera, Spilocuscus is characterized by a unique combination of traits, including sexual dichromatism in pelage coloration and pronounced sexual dimorphism, with females larger than males (HELGEN and FLANNERY, 2004). It is powerfully built and covered in thick woolly fur and weighs about 1-3 kg. The males are usually spotted, but sometimes also completely white, whereas the larger females are usually non-spotted and grey-brown in colour. The young go through a sequence of colour changes. Its solitary, nocturnal lifestyle means that it hides in the tree crowns or holes, or amongst masses of epiphytic vegetation during the day (MACDONALD et al 1993).

1.2.2 Grey Cuscus or Northern Common Cuscus (*Phalanger orientalis*)

Distribution

This species is native to Indonesia, Papua New Guinea, the Solomon Islands and Timor-Leste. It is distributed from the islands of Timor, Wetar and Leti through the Kai Islands and a number of the Moluccan Islands of Indonesia including Ambon, Buru, and Seram; it is present on the islands of Misool, Waigeo, Batanta, and Salawati, and ranges over much of the northern part of the island of New Guinea, including a number of offshore islands. It ranges as far east as the Bismarck Archipelago in Papua New Guinea, where it is present on many islands including the islands of New Britain and New Ireland. It also occurs on many of the Solomon Islands. Many of the insular island populations are the result of prehistorical introductions, possibly including: Timor, Seram, Buru, Sanana, the Kai Islands, the Bismarck Archipelago, and the Solomon Island chain (LEARY et al. 2008).

Description

It occurs primarily in disturbed habitats such as secondary forest, plantations, and gardens. The species is also present in primary tropical forest. The female usually gives birth to two young (MACDONALD et al., 1993; LEARY et al. 2008). This is an arboreal species, also powerfully built and covered in thick woolly fur. It weighs about 3-4.5 kg. The adult females are generally darker, greyish or reddish-brown, contrasting with pure white median ventral fur, while adult males are either buff, creamy coloured or white (MACDONALD, 2003). Juveniles of both sexes are usually reddish, or in the case of males, may be white. The fur is is less than 10 mm long with a dark dorsal stripe (MENZIES & PERNETTA, 1986).

2 Methods

2.1 Study site

The study site was in the Manusela National Park, which is situated on Seram Island, the second biggest island in the archipelago of the Moluccas, Indonesia. Seram island is located at 3°00’S, 129°00’E and has a size of 17,429 km² (Monk et al., 1997) with a length of 340 km for a width of 55-70 km. It has a population of about 353,000 (352,595 in pre-1990) (Monk et al. , 1997). The Manusela National Park was established in 1997 and has a size of 1751.55 km^2 (LAUMONIER, 2010).

Fig. 1 Location of Seram island in the Maluku province, Indonesia
(Magellan Geographix, 1997)

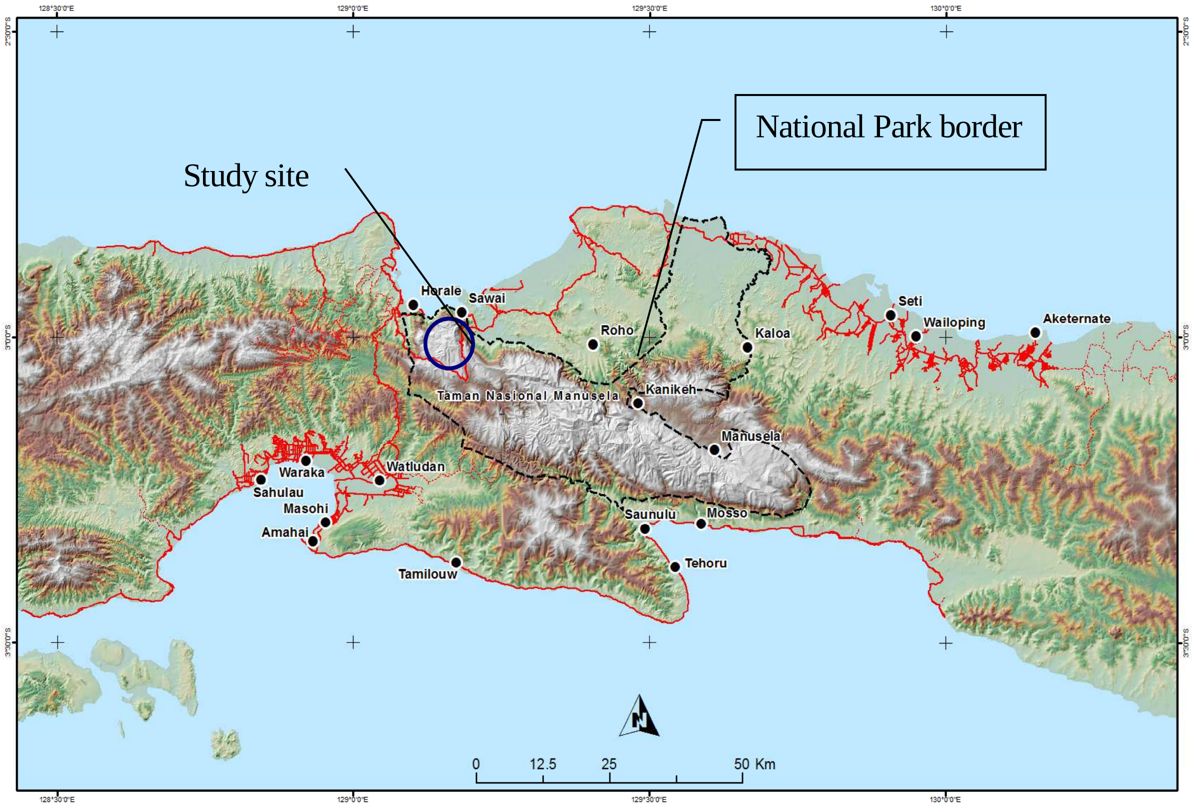

Fig. 2 Map of Central Seram with NP borders and study site (Setiabudi and Laumonier, 2012)

2.1.1 Climate

The climate of Wallacea varies from equatorial in the north, with high rainfall and diffuse sasons, and commonly a double rainfall peak, to monsoonal in the south with a single wet season and prolonged dry season. Within this overall pattern, there are complex varations according to altitude and exposure to the prevailing winds at different seasons. Generally the drier season lasts from June through October. Mean annual rainfall varies from as low as 500-1000mm (HOLMES, 1997). On Seram island yearly precipitation varies from 2000 mm to more than 3000 mm (FONTANEL and CHANTEFORT, 1978). Tehoru on the mountainous south coast of Seram receives, on average, over 800mm in July and 2170mm over the three months June to August (HOLMES, 1997). As general rule, mountainous areas have the highest rainfall.

Other climatic elements are more constant. Diurnal temperature variation exceeds the seasonal variation. At sea level, daily minima lie in the range 21-24°C throughout the year. Daily maxima average 30-34°C. Temperatures decrease with altitude, at a rate of 4 or 5°C per 1000 m. At 1000 m, mean minima and maxima are 17°C and 26°C, respectively.

Relative humidity is constantly high, falling from above 90% at dawn to 50-60% in the afternoon" (HOLMES, 1997).

2.1.2 Geology and Vegetation

Seram is part of a continental fragment originating from the Australian plate, (AUDLEY-CHARLES, 1993). It is a long and predominantly mountainous island. The highest peak Gunung Binaya (3027 m) is located in the central massif of the Merkele Ridge (HOLMES, 1997).
Seram's geological composition consists of mostly raised sedimentary and metamorphic rocks with a considerable part of it being Tertiary calcareous limestone formations and extensive ultrabasic formations that occur in the west. (EDWARDS et al., 1993 ; HOLMES, 1997). At the center of the island, stretching out towards the coasts, is the Manusela National Park (MONK et al., 1997).

The vegetation on Seram island consists of evergreen rain forest (MONK et al., 1997). The alluvial plains originally supported tall moist tropical lowland forest characterised by the only dipterocarp on Seram, *Shorea selanica*, and also *Canarium*, *Elaeocarpus sphaericus*, *Calophyllum*, *Intsia* and *Myrstica*. This forest is realtively open-crowned with sparse understorey. The lowland forest is characterised by *Octomeles sumatrana*, *Eucalyptus deglupta*, *Pometia pinnata*, *Casuarina equisetifolia*, *Ficus*, *Litsea* and *Eugenia*.
In higher altitudes (> 500 m asl.) the forest changes and typically includes conifers such as *Agathis alba* and *Dacrydium sp*, and the oaks *Lithocarpus* and *Castanopsis* in addition to *Casuarina, Duabanga moluccana, Dospyros, Calophyllum, Pterocarpus* and *Pinanga*. (HOLMES, 1997). Most trees are heavily covered with lichens, moss and ferns, especially at higher elevations. The understorey is generally sparse but with some patches of dense rattan *Calamus sp*. Forest stature declines with increasing elevation and above 2500 m asl. becomes 'elfin' in appearance and the understorey becomes dense with *Impatiens, Burmannia* and *Dianella* as well as *Rhododendron*, ericaceous shrubs, terrestrial orchids and tree ferns. No vegetation grows on the highest mountains (HOLMES, 1997).

2.1.3 Fauna

As is typical for the Wallacea region, the fauna of Seram shows mixed origins from New Guinea-Australia and Asia. Excluding introduced and probably-introduced species, the mammal fauna of Maluku consists of marsupials, murid rodents, and bats, which are the very same groups that dominate the modern mammal faunas of Australia and New Guinea (FLANNERY, 1997).

Human populations likely colonized Maluku in the late Pleistocene or early Holocene. They probably introduced large mammalian species found today in Maluku (LATINIS, 1996). On Seram island introduced big mammal species found nowadays include Celebes wild boar (*Sus celebensis*) and Timor deer (*Cervus timorensis*) (SASAOKA, 2008).

The Manusela National Park is best known for its bird species. It is home to more than 100 bird species, some of which, like the salmon-crested cockatoo (*Cacatua moluccensis*) are endemic (RUDIANTO, 2010).

2.2 Time of study

The fieldwork was conducted in the months of February and March 2011 (29.01.2011 – 18.03.2011). Interviews were held on four days (13. and 14. of March 2011 and 17. and 18. of March 2011).

2.3 Data collection

2.3.1 Interviews

The interviews were all carried out in the village of Masihulan, which borders the Manusela National Park on the north-western side. The village leader Julius Makatita, served as key informant. He provided information about the size of the village and the number of hunters. The village consists of 97 households with about 460 people and a total of about 45 hunters.

When number of hunters was known, 33% of the hunters (or 15 interviewees) were randomly selected for the interviews.

The interviews were face-to-face interviews and held by using semi-structured questionnaires and were conducted with one translator. Subjects were asked a set of questions to determine the kind of species they most frequently hunted and the hunting method and about the Manusela National Park.

2.3.2 Transect walks

The only street leading through the Manusela National Park was chosen as a baseline, since access would otherwise not have been possible. A random starting point was chosen on this baseline on a 5 km section. From this starting point, parallel transects were laid out spaced at 250 m from each other. 8 Transects leading into a southern direction, perpendicular from the baseline (WHITE and EDWARDS, 2000) and four transects opposite leading to the North.

Before cutting out the transects, a trial transect was made with the first intention of creating the transects at 2km length each. This however proved too ambitious since terrain was very difficult and the time needed to walk was much longer than estimated. The length was then reduced to 1.5 km but could also not be kept for all transects, because obstacles that could not be evaded were in the way. The transects finally had a length between 1 and 1.5 km.

A second site had to be chosen because terrain on the first site was impossible to walk (especially at night) and no more than the 12 transects could be laid out. The second site was about 15 km from the first site. A camp in the forest had to be created to walk those transects since it was too far from the first site to walk every day. On the second site 6 parallel transects were laid out in a southern direction from the baseline. The two sites were on different elevation levels therfore the first site had a vegetation type which led mainly through lowland forest but also through the transition zone to hill forest (site 1: 100- 550m asl). The second site led mainly through hill forest but parts were already in submontane forest (site 2: 700 - 800 m asl.) All the transects were inside the Manusela National Park in primary forest. A compass and measuring tape was used to to keep the right direction and spatial distribution while cutting the transects. Poles with flagging tape were placed every 50 m to faciliate the walks at night and to be able to measure the distance walked on the transect. All transects were allowed to settle for a minimum of two days to avoid bias of direct observations through disturbance that was created while cutting the transects.

Each of the 18 transects was walked three times at different daytimes on different days. One time in the morning (dawn) (4:30-8:30), one time in the evening (dusk) (16:30-20:30) and one time at night (21:00-1:00). One transect was walked up and then the parallel transect walked down. To walk one transect about 2 hours were needed and four transects were walked on one day.

Because the walks took mainly place in the dark, the spotlight method was used. It is one of the most wiedly used methods to survey arboreal marsupials (GOLDINGAY, 2004; LINDENMEYER, 2009). It involves using a large hand-held spotlight, the light of which will then reflect on the animal's eye, making it possible to detect it (LINDENMEYER, 1995). After the animal was detected, the species was indentified using binoculars. Due to different appearance of the two cuscus species and due to sexual and developmental dimorphism in both species, it was quite easy to identify the species and the sex of the observed animal.
The transects were walked with the same four people each time. All the sightings were of one animal only since cuscuses are solitary. Sometimes a mother with young in her pouch was detected, but since the gender of the young could not be identified and it only occurred five times, only the mother was counted.

GPS Points were taken for each sighting. Then the perpendicular distance was measured. Additionally information about the, species, sex, age, distance from the baseline, tree species on which sighting occurred and elevation was recorded.

2.4 Data analysis

2.4.1 Interviews

Interviews were analysed using Excel 2007 software. For adequate data, a Spearmank rank correlation and the Mann-Whitney-U test were done using STATISTICA Version 10 software.

The Spearman rank correlation is used to determine the strength of the relation of two variables. The Spearman correlation is computed from ranks. It assumes that the variables under consiederation were measured on at least an ordinal scale but linearity and normal distribution are no assumptions for the test (LEYER and WESCHE, 2007).

For the Spearman rank correlation the significance level was set at 5 %, meaning that a p-value of < 0.05 showed statistical correlations between the tested variables.

The Mann-Whitney-U test is a nonparametric alternative to the t-test for independent samples. But unlike the t-test it does not make assumptions homogeneity of variances or normal distribution (DYTHAM, 2003). The Mann-Whitney-U test is based on rank sums rather than means. Therefore the data has to be converted into ranks before carrying out the test.

The signifiance level was again set at 5%.

2.4.2 Transect walks

2.4.2.1 DISTANCE Software

Densities for the Northern Common Cuscus and the Spotted Cuscus were estimated using the software DISTANCE 6.0. Release 2 (THOMAS et al. 2006). Since the study area was not known , only densities and not abundance could be estimated.
According to BUCKLAND et al. there are 3 assumptions that are essential for reliable estimation:

1. Objects directly on the line or point are always detected g(0)=1
2. Objects are detected at their initial location, prior to any movement in response to the observer
3. Distances are measured accurately.

The formula which estimates the densities is:

$$\hat{D} = \frac{1}{2}\frac{n}{L}\hat{f}(0)$$

The parameter f(0), estimated by $\hat{f}(0)$, corresponds to the probability density function of the perpendicular distances, evaluated at zero and can also be interpreted as 1/μ, where μ is the perpendicular distance from the transect line where the number of undetected objects is equal to the number of objects that were detected beyond it. μ is the effective strip half-width. When multiplied by 2L gives the effective area surveyed. Thus estimation of the density of objects can be easily obtained from estimates of encounter rate (n/L) and f(0) (BUCKLAND et al. 2001).

The data was truncated at the largest 5% of the distances to avoid outliers because these distort the results which is the area close to the line (GIBBS, 2008). Post-stratification was done for the two different sites. Site 1 was the lowland habitat and Site 2 the highland habitat. 4 different models were tested: Halfnormal+cosine, Uniform+cosine, Hazard-rate+cosine and Negative Exponential+cosine. The model with the lowest AIC (Akaike's information criterion) result chosen, since it provides an objective, quantitative method for model selection (BUCKLAND et al. 2001)

2.4.2.2 Logistic Regression

Binomial or binary logistic regression refers to the instance that the observed outcome can only have two possible types, usually coded as "0" and "1" in binary logistic regression as it leads to the most straightforward interpretation. The target group, also called "case", is usually coded as "1" and the reference group, also called "noncase", as "0" (BACKHAUS et al. 2006).

The logistic regression is expressed through the following formula:

$$p_k(y=1) = \frac{1}{1+e^{-z_k}}$$

with

$$z_k = \beta_0 + \sum_{j=1}^{J} \beta_j \cdot x_{jk} + u_k$$

Where z_k expresses the logistic function and e is the mathematical constant e= 2.71828183. The logistic regression estimates the probability for the event y=1 by using the logistic function (BACKHAUS et al., 2006).

Logistic regression is also used to predict the odds of being a case based on the predictors. The odds are defined as the probability of a case divided by the probability of a noncase. The odds ratio is the primary measure of effect size in logistic regression and is used to compare the odds that membership in one group will lead to a case outcome with the odds that membership in some other group will lead to a case outcome (BACKHAUS et al. 2006)

Compared in this study was the preference of the two species with estimates for Night/Twilight, Site 1 (lowland)/Site 2 (highland) and the distance from the baseline (street).

3 Results

3.1 Transect walks

3.1.1 DISTANCE

Species 1

	MODEL			
	Halfnormal+cosine	Uniform+cosine	Hazard-rate+cosine	Neg. exponential+cosine
AIC	269.72	269.32	270.98	268.58
ESW	10.797	10.916	9.1916	7.9033
D	31.0	30.663	36.414	42.350

Species 2

	MODEL			
	Halfnormal+cosine	Uniform+cosine	Hazard-rate+cosine	Neg. exponential+cosine
AIC	173.13	171.55	174.94	172.76
ESW	18.732	21.400	17.180	16.208
D	8.4159	7.3667	9.1759	9.7265

Tab. 1 Comparison of the different models for Species 1 (Northern Common Cuscus) and Species 2 (Spotted Cuscus) with AIC (Akaike information criterion), ESW (effective strip width) in m and D (Density) in number/km^2

The analysis with DISTANCE was performed using several models to see which model gives the best fit for the data. The AIC is a measure of the realtive goodness of fit of a statistical model and provides a quantitative method for model selection. The model with the lowest AIC is selected for inference (BUCKLAND et al.2001). All data were truncated to discard the largest 5% of distances and post-stratification was used for the lowland habitat (Site 1) and the highland habitat (Site 2).

In this case the best result for the Northern Common Cuscus (Species 1) is by selecting the Halfnormal+cosine model and for the Common Spotted Cuscus (Species 2) the Uniform+cosine model.

The effort walked was 72.15 km in total. For the Northern Common Cuscus there were 48 observations in total. The pooled mean estimates of Site 1 and Site 2 for the density of the Northern Common Cusucus were 31/ km^2.

For the Common Spotted Cuscus there was a total of 28 observations. The pooled mean estimates of Site 1 and Site 2 for the density of the Common Spotted Cusucus were 7.36/ km^2.

Northern Common Cuscus Halfnormal+cosine model:

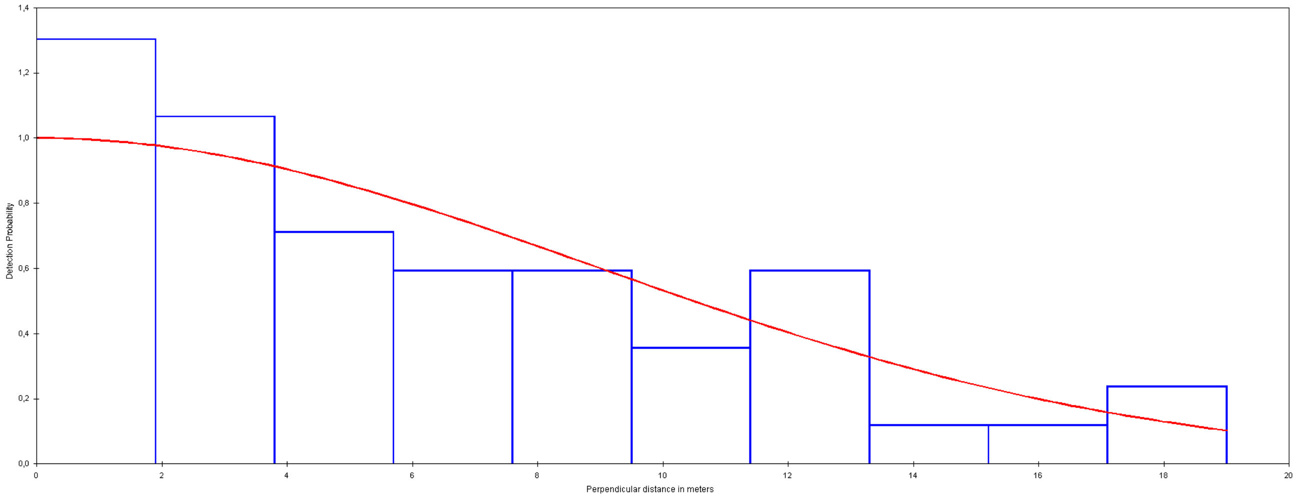

Fig. 3 Histogram of perpendicular distances of the observations of the Northern Common Cuscus from the transect

The histogram in Fig. 3 shows that the probability of detection is highest at distances smaller than 2 m, with that probability decreasing as the idistance gets larger. The curve is the fitted detection function, in this case a “normal” or Gaussian curve, adjusted to fit the observed frequencies as closely as possible.

Common Spotted Cuscus Uniform+cosine model:

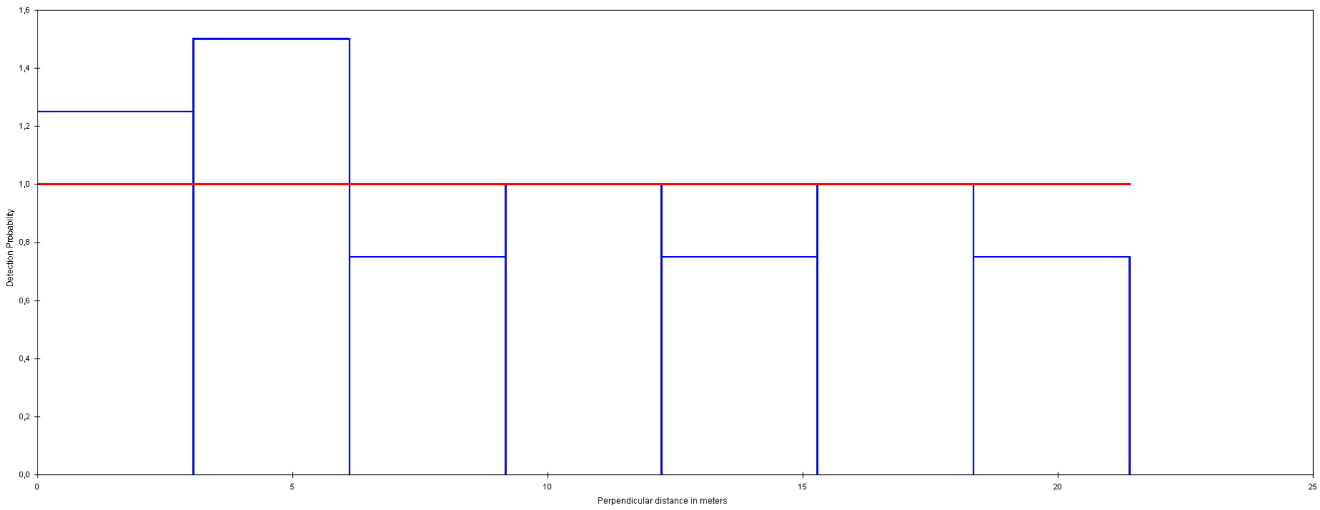

Fig. 4 Histogram of perpendicular distances of the observations of the Common Spotted Cuscus from the transect .

It can be seen in the historgram in Fig. 4 it that the detection probability was highest at distances smaller than 7 m. Here, however, the Uniform fitting was chosen instead of the normal curve because the AIC showed slightly better, that is lower, results for this model.

3.1.2 Logistic Regression

	Estimate	Standard Error	Lower CL 95%	Upper CL 95%	p
Effect					
Intercept	0,22472	0,938435	-1,61456	2,064039	0,810731
Night	3,59558	0,813473	2,0012	5,189958	0,00001
Site 1	-2,3321	0,934155	-4,16301	-0,501189	0,012543
Distance from street (m)	0,00138	3,21458	-0,00013	0,002885	0,072985

Tab. 2 Parameter estimates Significance for > 0.05 with a binominal distribution and the modeled probability that Species 1 = 1

Regression forumula for the determination of z-values (logits):

z = 0,22474 +3,59558xNight - 2,33210xSite1 – 0,00138xDistance

Estimate ‚Night' = 3,59558, which means increasing x-values result in a higher probablity of the characteristic y=1: At night the probability rises that there is a sighting of the Northern Common Cuscus (Species 1) compared to the Spotted Cuscus (Species 2).

Estimate ‚Site 1' (lowland) = -2,33210: On the lowland site (Site 1) there is a lower chance of the sighting of the Northern Common Cuscus in comparison to the highland site (Site 2) and the Spotted Cuscus.

Estimate ‚Distance from street' shows no significant result.

Observed	Classification of cases Odds ratio: 20,500000 Log odds ratio: 3,020425 Predicted 1	Predicted 0	Percent correct
1	41	10	80,39216
0	5	25	83,33333

Tab. 3 Predicted versus observed values.

Table 3 shows that the predicted values are close to the observed values. There is a right prediction for value 1 of 80% and for value 0 of 83%.

Effect	Species 1 - Odds Ratios Distribution : BINOMIAL, Link function: LOGIT Modeled probability that Species 1 = 1 Level of Effect	Column	Odds Ratio	Lower CL 95, %	Upper CL 95, %	p
Intercept		1	1,25200	0,198978	7,8777	0,810731
Night		2	36,43687	7,397961	179,4610	0,000010
Site 1		3	0,09709	0,015561	0,6058	0,012543
Distance from street (m)		4	1,00138	0,999872	1,0029	0,072985
Scale			1,00000			

Tab 4. Odds ratios

The Odds Ratio for Night in Table 4 shows that the chance of seeing the Northern Common Cuscus (Species 1) at night is 36.5- times higher than during the twilight and compared to the Common Spotted Cuscus.

The Cox-Snell test and the Nagelkerke test are used to show the goodness of fit of a model. In this model the value of t > 0,2 for the Cox-Snell test shows a good fit and the Nagelkerke test with a value of > a very good fit.

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3.2 Interviews

INCOME SOURCES AND FOREST USE

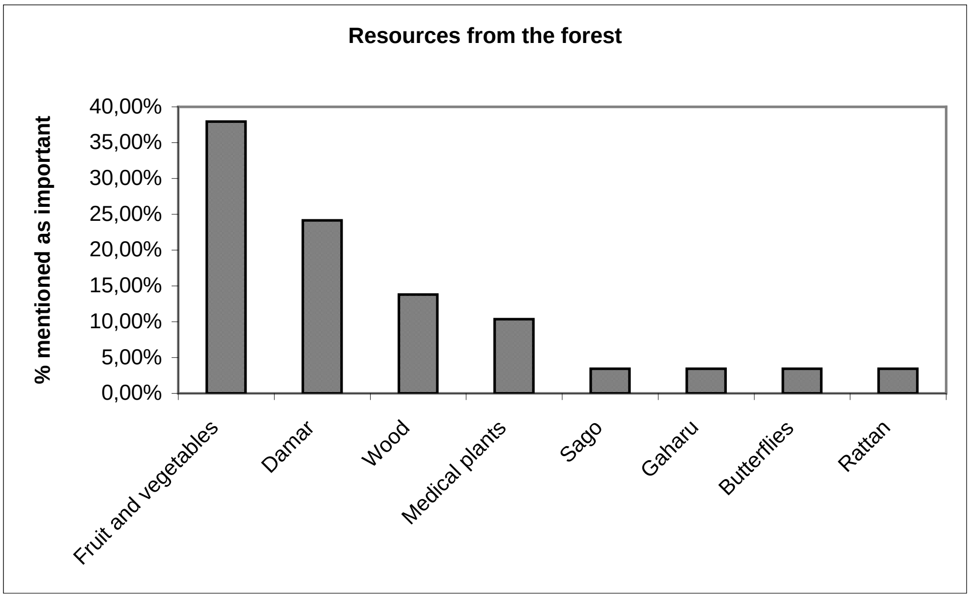

Fig.. 5 Resources taken from the forest

Figure 5 shows the income resources that the respondents take out from the forest. Most important are fruit and vegetables with 37.93%. Followed by damar (24,14%) and wood (13,79 %). Damar is the resin of *Agathis* spp., which is often sold to local traders. Other resources taken out from the forest include medical plants and sago (starch extracted from the sago palm).

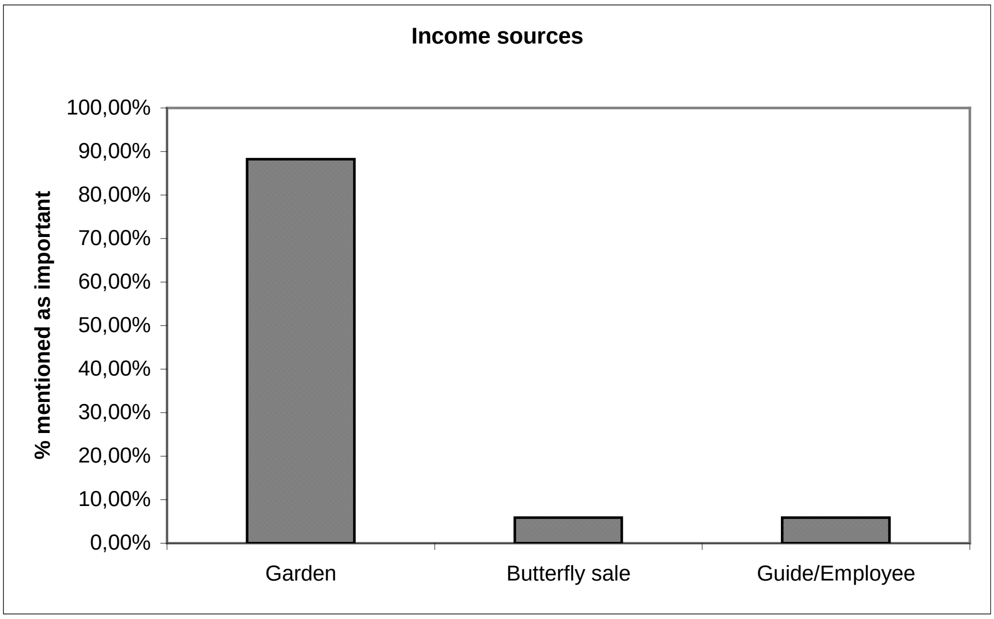

Fig. 6 Income resources

In Figure 6 the general income resources are shown. The largest income resource is the garden (88.24%). Only 5.88% sell butterflies or are employed.

Figure 7 specifies the plants grown in the garden for subsistance and sale. Most important are Cocoa (34.28%), Banana (22.86%) and Coconut (11.43%).

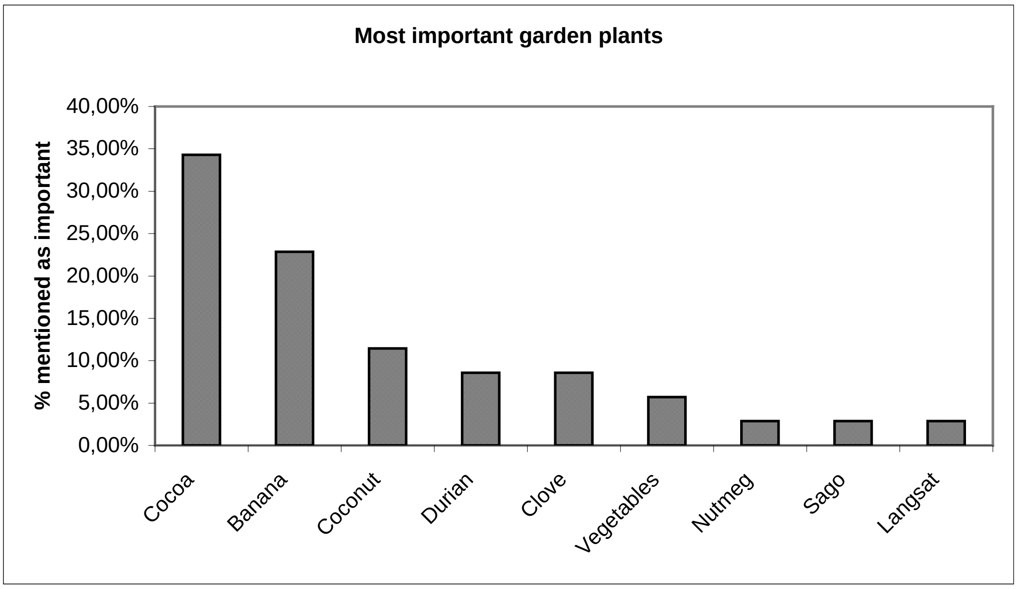

Fig. 7 Most important plants grown in the garden.

THE NATIONAL PARK

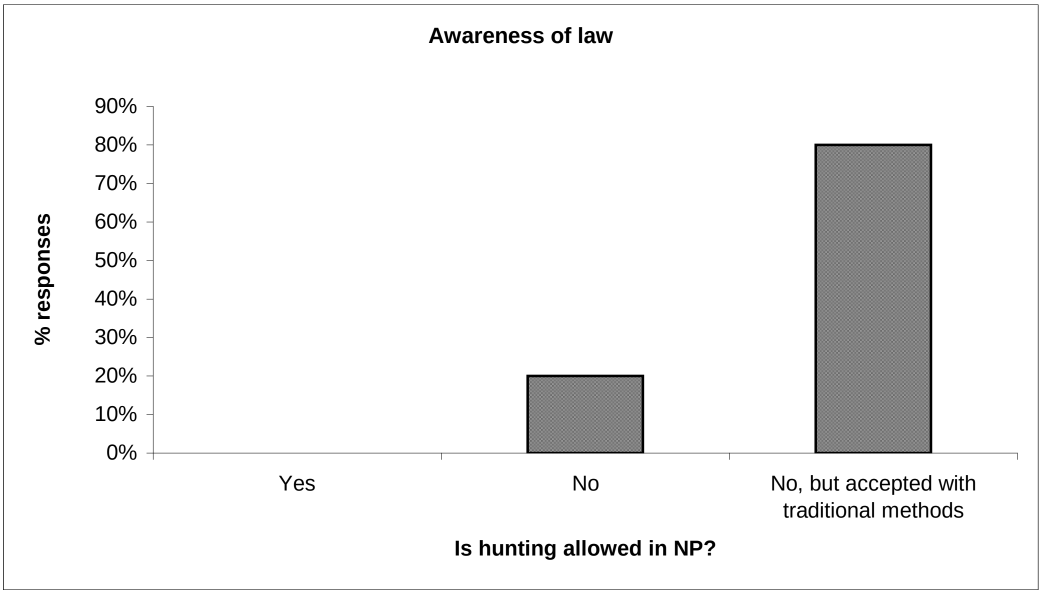

Fig. 8 The awarness of the National Park law.

Figure 8 shows the result to the question if the respondent thought that hunting is allowed in the National Park or not. All respondents claim, that hunting is not allowed in the National Park, however 80% said that even though it was not allowed, it would be accepted if hunting was performed with traditional weapons. The actual law was asked from the National Park Office which confirmed the statement that hunting is not allowed by law but there is no law enforcement if only traditional hunting methods are used.

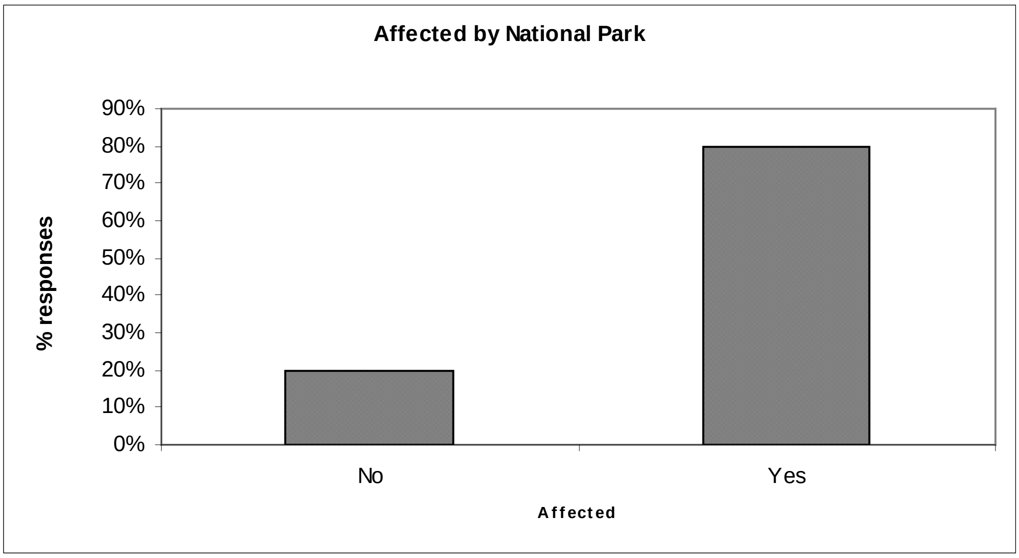

Fig 9 Effect of the National Park on local people.

This question was asked because Masihulan village directly borders the National Park. As could be expected, 80% of the respondents felt affected by the National Park, only 20% claimed no effect. The reason given was always a negative impact and all respondents that felt affected had the same reason, which is “decreased hunting possibility”.

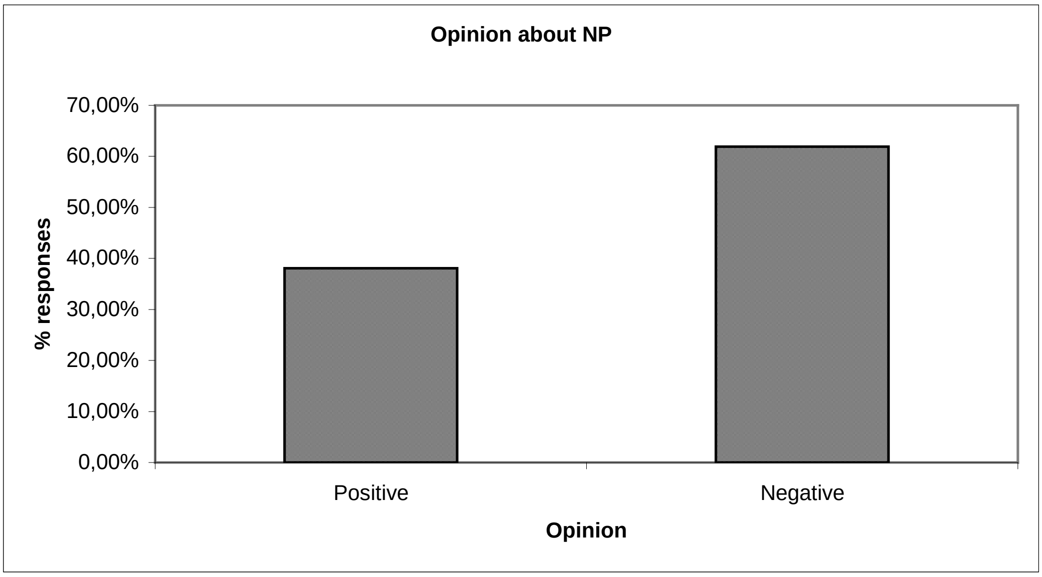

Fig. 10 Opinion of the respondents about the National Park

The opinion about the National Park as Fig. 10 shows was mainly negative (60%). Still 40% of the interviewees could also see positive reasons for the existence of the National Park. The negative reasons given were: limited hunting activity (see also Fig. 9), the failed promise of the National Park for compensation and that land could not be expanded for income increase. On the positive side were protection of resources, income through ecotourism and the positive effect for the future generation.

HUNTING

Fig. 11 Use of meat for consumption or sale

All respondents claimed that the meat was only for personal use and no sale took place. Apparently in the past, dendeng (prepared meat) was sometimes sold to the market but this is of no more importance.

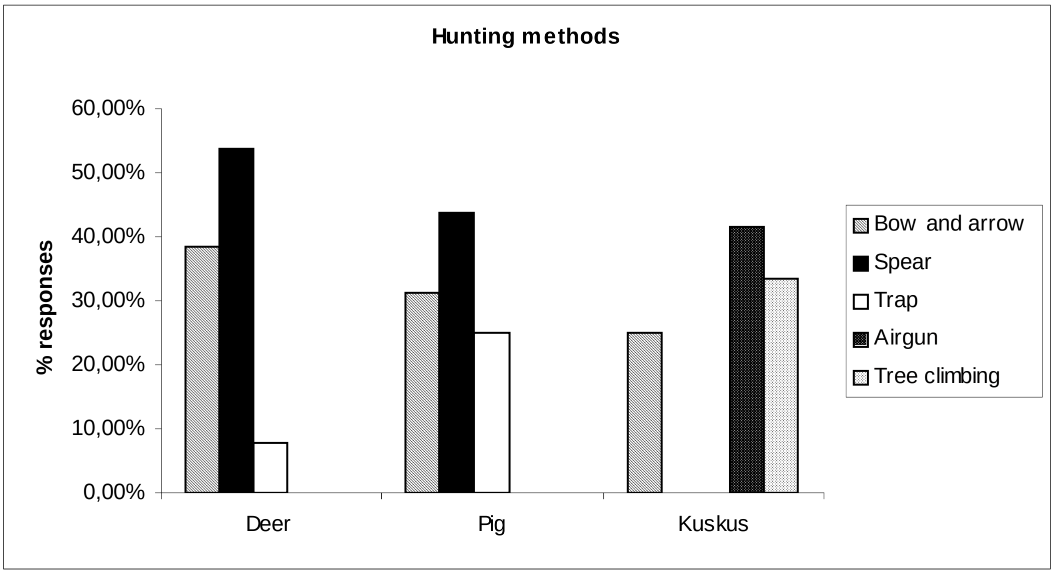

Fig.12 Hunting methods used for different animals (deer, pig and kuskus)

Fig. 12 shows that there are different hunting methods used for different animals. Deer (*Cervus timorensis*) is mainly hunted with a spear (53.84%) but also with bow and arrow(38.46%), pig (*Sus celebensis*) shows similar results as for deer except that traps also play an important role in hunting for pig (25%). For Cuscus (*Phalanger orientalis* and *Spilocuscus maculatus)* The bow and arrow are also used (25%) but most important hunting methods for cuscus nowadays is the airgun (41.66%) followed by the traditional climbing of the trees (33.33%) to catch it by hand or shoot it with an arrow from there.

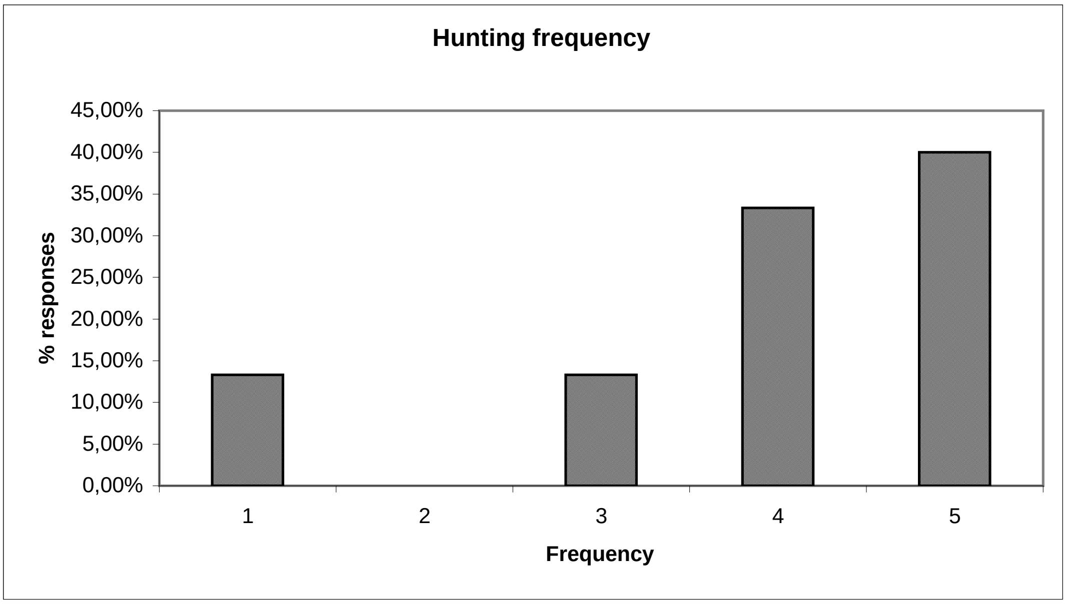

Fig. 13 Hunting frequency in categories

Frequency of hunting trips		
1 = rarely	Mean	3,86666667
2= once in 2 or 3 months	Standard deviation	1,35576371
3 =once a month	Median	4
4 = once per week		
5 = several times a week		

Tab. 5 Categories for the hunting frequency.

The hunting frequency was put into 5 categories as can be seen in Table 6. The mean value of the frequency was 3.86 meaning that people in average go hunting about once a week.

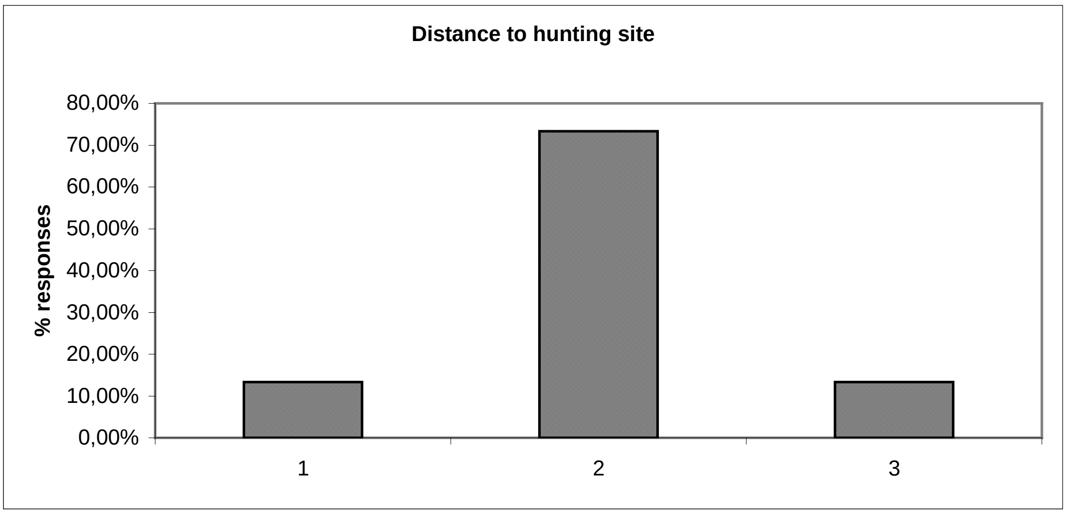

Fig 14 Distance to the hunting site in categories

Frequency		
1= < 5 km	Mean	2
2= 5-15 km	Standard deviation	0,534
3= >15 km	Median	2

Tab. 6 Categories for the distance to the hunting site

The distance to the hunting side was also put into categories (see Table 7). Most hunters go a distance of 5-15 km to their hunting site.

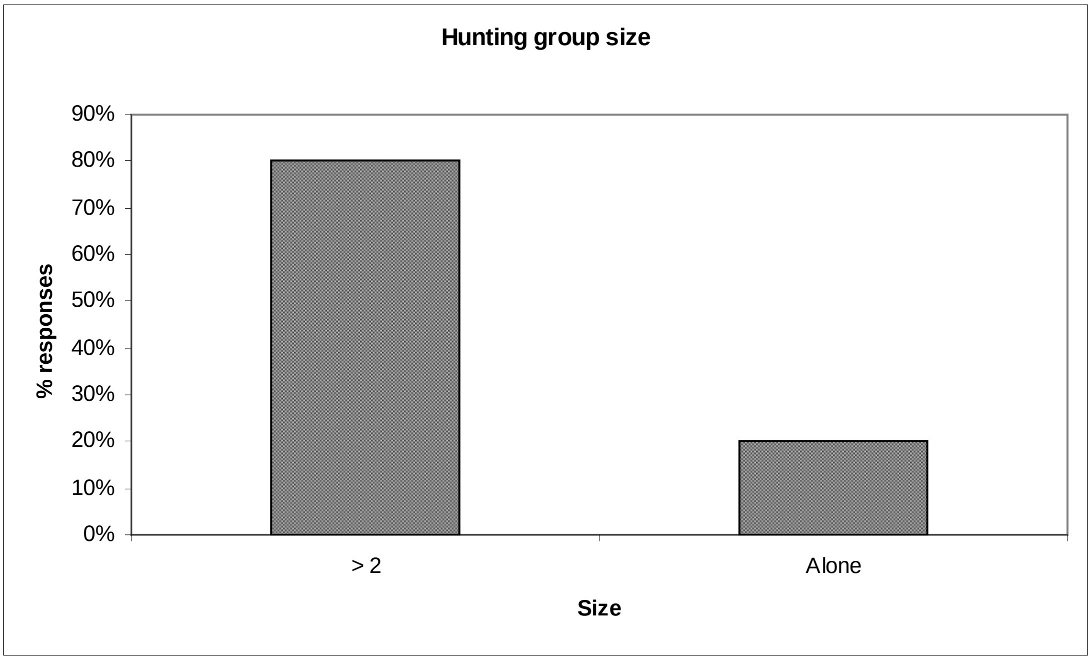

Fig 15 Hunting group size

Almost all hunters go hunting in groups of two or more people (80%) and it is seldom a solitary activity.

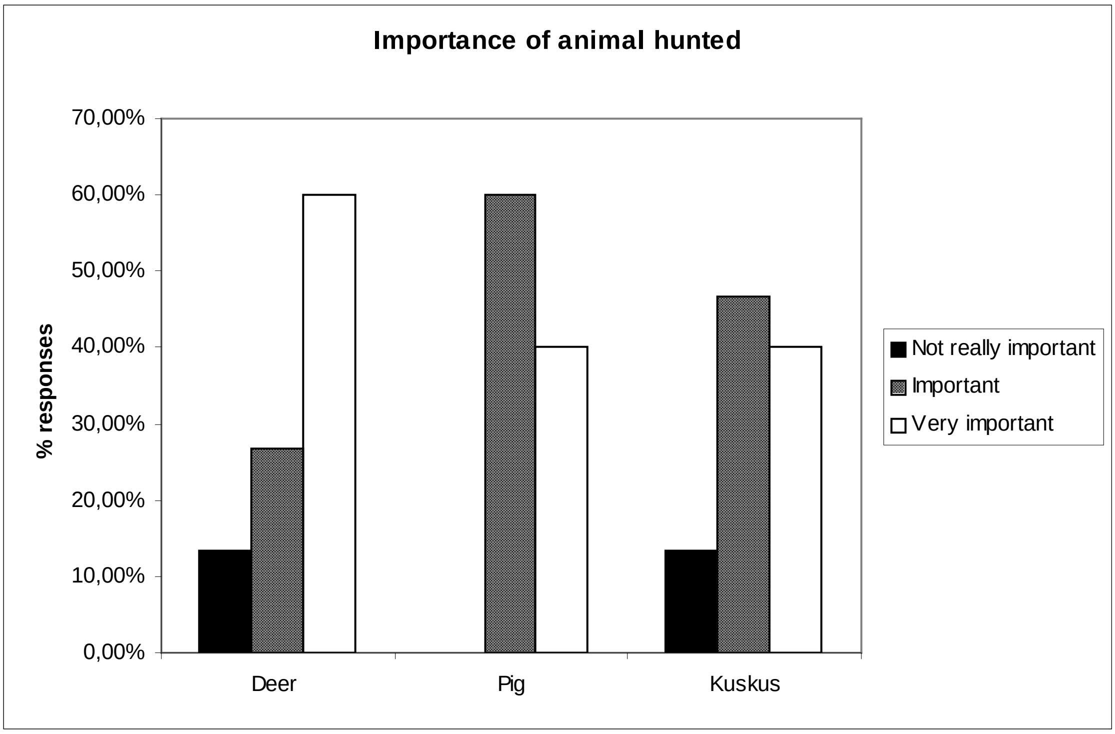

Fig 16 Importance of the different animals to the hunters

The most important species hunted by the villagers were ranked according to their importance. 60% claimed that deer is a very important game species to them, making it seem the most important. Pig and Kuskus were equally mentioned as very important (40% each), however pig is still important to 60% and kuskus only to 46%.

Some people are specialised on one animal species, for example kuskus, when they are good climbers and all animals seem to take an important part in the diet of the people.

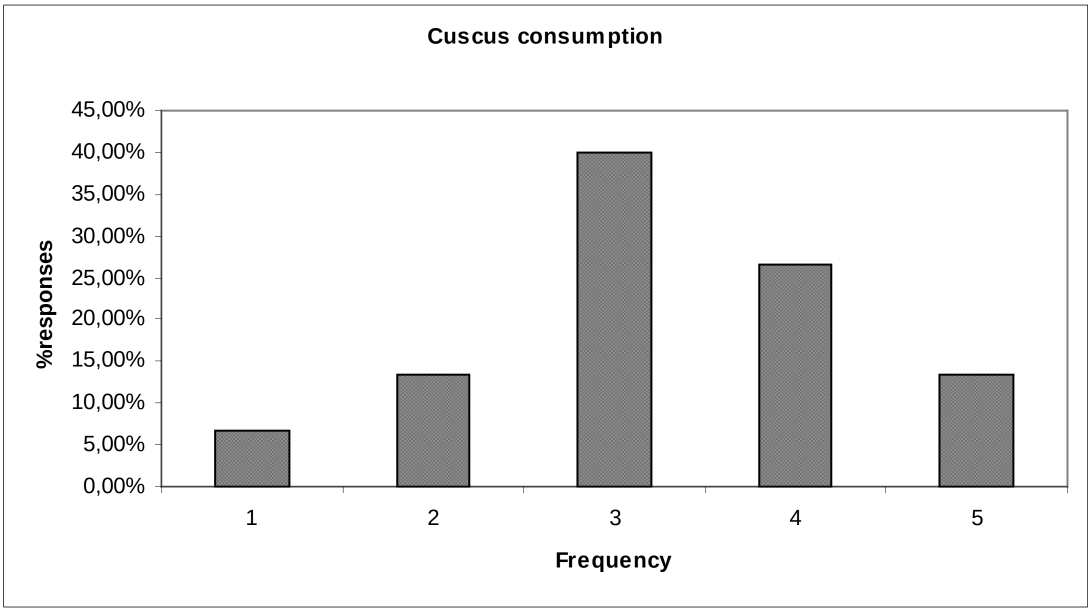

Fig 17 Cuscus consumption in categories

Frequency of cuscus consumption		
1 = rarely	Mean	3,26666667
2= at least once per quarter	Standard deviation	1,09978353
3 = at least once a month	Median	3
4 = once per week		
5 = several times a week		

Tab. 7 Categories for the frequency of cuscus consumption

Cuscus consumption was also categorised into five classes explained in Table 8. The table and Figure 17 show that the people consume cuscus in average about once a week.

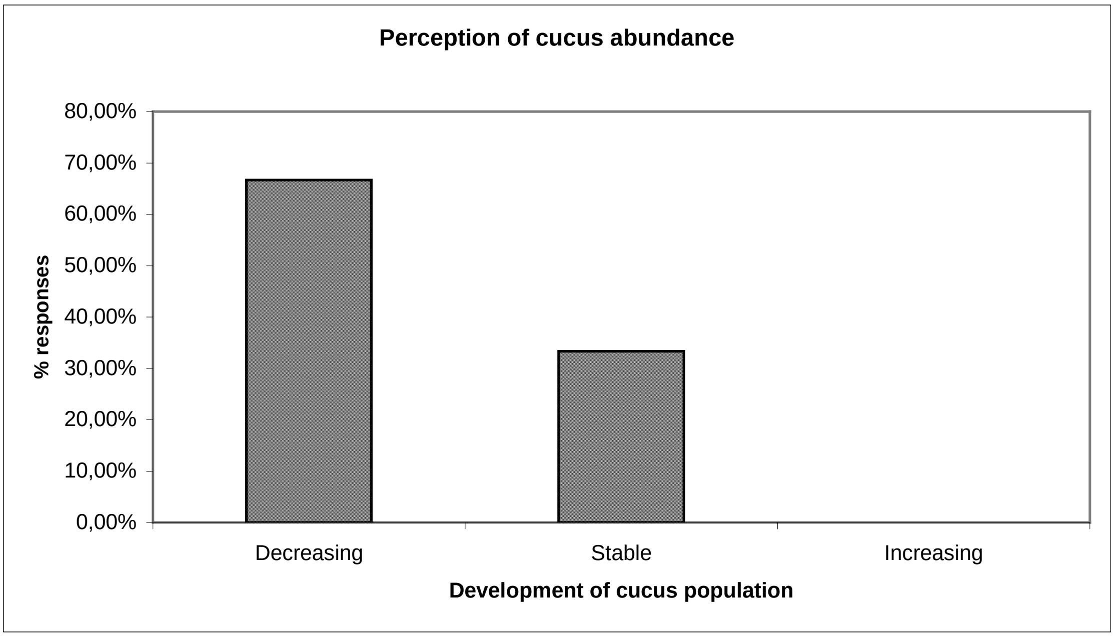

Fig 18 Perception of cuscus abundance

The perception of the development of cuscus abundance was given as seen in Figure 18. 66.67 % perceived the cuscus population as decreasing. The rest saw them as stable and none as increasing. Asked for the possible reasons for the perceived decline the ansers were the change of hunting methods towards new technologies (airgun) and the increase of hunters from outside the village due to the street that was built in 1998 and opened for public transport in 2005.

Hunting site and distance to it

Site	% mentioned as important hunting site	Distance (km)	Inside NP
Apilima	20	5	Yes
Kapala Ili	16	15	Yes
Patikutuhuey	10	10	Yes
Mutunahuey	8	15	Yes
Taleta	8	7	Yes
Bale-Bale	6	5	Yes
Loa-Loa	6	5	Yes
Ruihelu	6	15	Yes
Salawai river bank	4	3	No
Kalileu	2	10	Yes
Kasane	2	4	No
Kuku	2	4	No
Mauli	2	8	Yes
Talaga	2	8	Yes
Uni	2	1	No
Wai Utu	2	4	No
Wayanahuey	2	4	No

Tab.8 Ranking of the distance to the different hunting sites according to the importance of the hunting site (%).

3.2.1.1 Spearman rank correlation

Pair of variables	n	Spearman R	t	p
Distance (km) and Distance (km)	17	0.494927	2.205.971	0.043398

Tab. 9 Spearman rank correlation results with correlations significant at > 0.05

The Spearman rank correlation was used to show if there is a correlation between the hunting sites that are most popular with the hunters and used most often and the distance to reach that site. With a p-value of 0.043, the result proved significant meaning that hunting sites that are further away are more important than the ones close to the village.

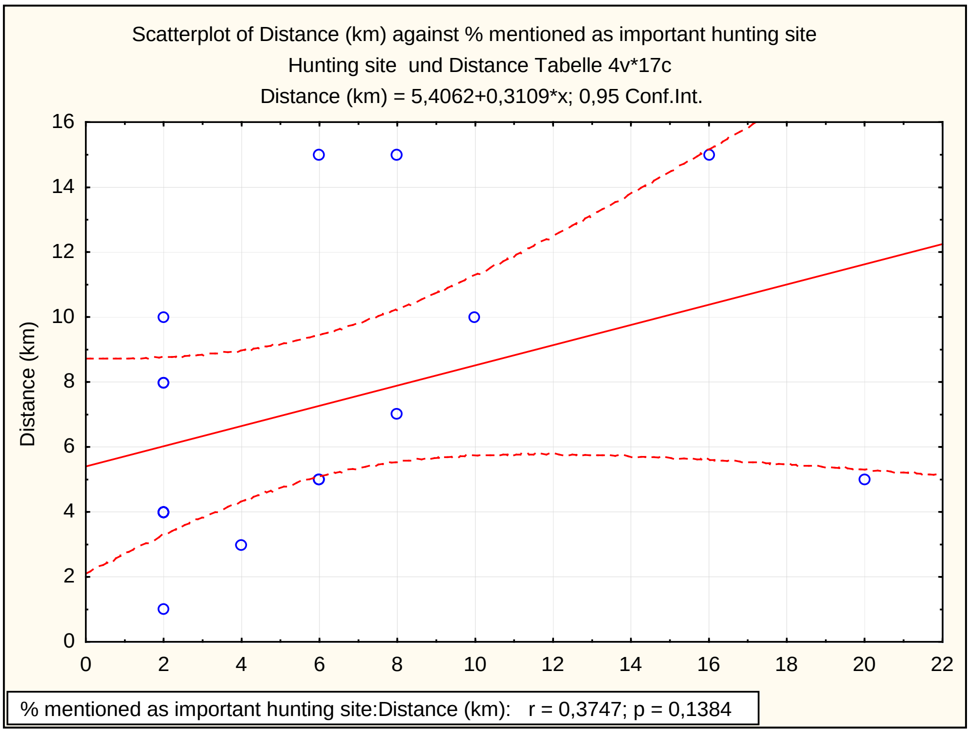

Fig. 19 Correlation between the most important hunting sites and the distance to the hunting site.

Figure 19 shows the correlation between the distance to the hunting site and the % mentioned as an important hunting site. The parametric correlation between the two scales is shown in the bottom of the scatterplot (r=0.37). Interestingly, the correlation is lower in the scatterplot than than the Spearman rank order correlation (see Tab. Spearman R=0.49). For a larger sample size it could be concluded that treating the information in the data as ranks improves the estimate of the relationship between the variables by blocking out random variability and dampening the effects of outliers.

3.2.1.2 Mann-Whitney-U test

variable	Mann-Whitney U Test (Hunting site und Distance Tabelle) By variable Inside NP Marked tests are significant at p <,05000 Rank Sum Yes	Rank Sum No	U	Z	p-value	Z adjusted	p-value	Valid N Yes	Valid N No	2*1sided exact p
% mentioned a	121,5000	31,50000	10,50000	2,211083	0,027031	2,342518	0,019155	11	6	0,020200

Tab. 10 Results of the Mann-Whitney-U test

The Mann-Whitney –U-Test shows a significant result (p<0,02) for the variable '% mentioned as hunting site' which was tested against 'inside NP'.

Fig. 20 Boxplot by group (Inside/outside National Park)

The box plot indicates, for the dependent variable (important hunting site), the median, quartiles and range for each category of the grouping variable.

It is apparent from this plot that most of the important hunting sites were inside the National Park.

4 Discussion

4.1 Density estimations

The transect walks were performed for six weeks, almost every day. Still the amount of data that could be obtained was not very large.

The data evaluated from the transect walks showed a pooled mean density for the Northern Common Cuscus of 31/km^2 and for the Common Spotted Cuscus of 7.36/km^2. However BUCKLAND et al. (2001) state that there should be at least 40-60 observations for estimating densities and abundance of a species. As can be seen in Table 12, the observations were especially low for the Common Spotted Cuscus. In total there were only 28 observations and for the stratum in the highland habitat, there were only two observations. Therefore it could well be, that the density estimates are not very accurate.

	Effort	Observations Lowland	Observations Highland	Observations total
Northern Common Cuscus	72.14 km	31	17	48
Common Spotted Cuscus	72.14 km	26	2	28

Tab 11 Observations of the two cuscus species

4.2 Spotlight method

Also the spotlight method might have caused some underestimation. Although it is a widely performed method (GOLDINGAY, 2004), there have been studies that show that there were underestimations for arboreal marsupials on which that method was used. LINDENMEYER et al. (2001) found that only 10-60% of the indivuduals were detected with spotlights.

Additionally the dense forest cover might have caused a bias in the detection probability. Sometimes animals were heard but could not be detected with a spothlight. Therefore the density estimates that resulted of this study have to be read carefully.

Also, no comparison data could be found for this area. Further research should be done to show the development of densities of the cuscuses on Seram Island, especially since there seems to be a change in hunting methods and more pressure through improved access to the forest, as the results from the interviews show.

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4.3 Logistic Regression Model

The logistic regression model shows quite obviously that the species do have different preferences. Especially the activity at different times of day differs significantly. The Northern Common Cuscus seems to be most activite during the night while the Spotted Cuscus, in comparison, was more active during the twilight hours of the morning and the evening. The two categories for time of activity “morning” and “evening” were added to the category “twilight” and then compared to “night”. This achieved even more obvious results than testing “morning”, “evening” and “night” against each other.

Also, the comparison of the lowland and highland habitat for the two species showed significant results. There is a greater chance of finding the Northern Common Cuscus in higher altitudes than the Spotted Cuscus. This is also mentioned in MACDONALD et al. 1993, where there was a Northern Common Cuscus found on altitudes up to 2500 m asl.

The reason might be that they have a preference for different trees that they feed on. This, however, would need further investigation.

4.4 Interviews

Because the sample for the interviews is quite low (n=15), no significant statistical tests could be done. But the results still show tendencies of the hunting pattern, with a special focus on the kuskus and hunting in the National Park. There might also be a bias, because all interviews were held in local language and had to be translated through an interpreter.

The Cuscus does seem to play a role as a protein source for local people but apparently, deer and pig are still more frequently hunted than the cuscus.

The study of LATINS (1996) found similar results. However SASAOKA (2008) made an anthropological study in a remote mountain village on Seram island, where he found that cuscus plays a very important role in the daily diet of the local people.

The questionnaires showed, that the traditional hunting methods – spear, arrow and traps - are still preferred. They are tolerated by the National Park rangers, but not officially allowed. For hunting the men usually do trips of around 5-15 km in the surrounding area, both inside and outside the National Park, but mainly inside the National Park, as the Mann-Whitney-U test showed.

According to the hunters, there are less cuscuses to be found in the area nowadays than compared to 10 years ago. The possible reasons are less numbers or another possibliy could be the movement to areas that are less disturbed, due to increased hunting pressure after the street was opened through the National Park in 2004.

The most important protein sources are deer and wild pig, which are hunted with dogs, although some hunters, ususally good tree climbers, are specialised on cuscus . The meat of all species is only for personal use not for sale. A change in the younger generation is that they are not so interested in traditional hunting methods and therefore there is a shift towards increased air-rifle use. Still, air guns are not yet often used by locals if one looks at the hunting methods for all animals in general. However, for cuscuses it is already the preferred hunting method. A big problem is caused by the street that was opened in 2005 – now people from outside, that often hunt with air rifles, have access to the area.

The main income of the villagers are the homegardens in which mainly cacao, banana, durian, nutmeg are grown and used for self-consumption and for sale. Also ecotourism, especially bird watching, has a small impact in the area. Damar, the resin of *Agathis spp*., and in some cases the sale of butterflies gives an additional income to the villagers.

The villagers were also asked about their opinion on the National Park. The disadvantages of the NP that were mostly mentioned are the loss of customary land and that there is no adequate compensation for income losses which therefore leads to illegal logging and hunting. Some villagers could also see advantages of the NP like alternative income through ecotourism and resource protection. The expectations they have from the NP are help with establishing ecotourism and compensations.

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