IMPACT OF DISTURBANCE OF WILD *MACACA NIGRA* POPULATIONS AND HABITATS IN SULAWESI

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Team

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Summary

Sulawesi is highly regarded for its species biodiversity and has the highest level of endemism within Indonesia: 88/328 (27%) bird species; 79/127 (62%) mammal species, though this rises to 98% is only flightless mammals are included. In addition, to supporting the evolution of seven endemic macaque species (including the M. nigra), this area is important to other threatened species including anoa (*Bubalus depressicournis*), babirusa (*Babyrousa babyrussa*), maleo (*Macrocephalon maleo*), Minahasa masked-owl (*Tyto inexspectata*) and the satanic nightjar (*Eurostopodus diabolicus*). *M. nigra* are a key species within their ecosystem (in Northern Sulawesi) and the study of their population and distribution can provide an indication of habitat quality which has far-reaching implications for many other plant and animal species.

Currently *M. nigra* are considered Endangered (IUCN, 2006); determined from data collected in 1996 (Eadey *et al*., 2000). Unfortunately, surveys of *M. nigra* population densities have to date be confined to a few areas within their home range of Minahasa (Northern Sulawesi). The majority of census data has been collected at Tangkoko DuaSudara Nature Reserve, where there are large groups of habituated macaques. Hence it is likely that observations of macaques will be easier in Tangkoko and thus artificially higher than those estimated in other regions of Minahasa. Surveys conducted at Tangkoko highlighted that *M. nigra* populations are declining. In one of the first *M. nigra* surveys up to 300 individuals/km^2 were recorded by MacKinnon and MacKinnon (1980). This declined in under 20 years to 76 individuals/km^2 (Sugardjito *et al*., 1989) and a further 10 years later numbers were recorded to be between 66.7 – 23.5 km^2 (Rosenbaum *et al*., 1998). Tangkoko DuaSudara Nature Reserve is a protected area, which attracts many eco-tourists affording it protection from hunting and farming (Kinnaird and O'Brien, 1996). So it is likely that the *M. nigra* population in Tangkoko is again artificially higher than that found in other parts of its range. Surveys of villagers suggest that few macaques exist outside the nature reserves (Feistner, 2001). It is likely therefore, that now (2007), 30 years after the MacKinnon's survey population densities of *M. nigra* have decreased still further and their long-term survival is questionable.

This project was set up to initially gain an insight into the distribution and estimation of *M. nigra* population density in the entirety of its range in Minahasa. To ensure data were comparable with previous surveys, similar data collection methods were used to estimate *M. nigra* densities and distribution (e.g. Rosenbaum *et al*., 1998). Twenty-two sites were surveyed within the 300 km^2 range of *M. nigra* throughout Minahasa, Northern Sulawesi; nine other sites were not surveyed as they consisted of too much farmland or were inaccessible. The sites represented both protected and unprotected areas. Interviews were conducted in villages prior to walking trails, to identify possible trails and gain a insight into human-animal interactions (of villagers' perceptions) in the area (e.g. Lee, 2000).

Fifty two trails (a total of 150.14km) were walked, ranging from 1km - >10km depending on the terrain. They were walked quietly with stops every 100m to visually scan and listen for calls and conducted between 0600 and 1200. A total of 8 macaque

sightings were made along these trails, totalling 72 animals; 4 sightings were made in Tangkoko DuaSuadara Nature Reserve accounting for 60 animals, of which 50 were part of a habituated troop. Human disturbance was measured through observations of traps along trails, which was highly variable. Unfortunately, the protection bestowed on areas through providing them with nature reserve status did not reduce hunting pressure. For example some of the highest numbers of traps (>50) were observed in the Ambang reserve. Bird lists were also taken along each trail. Fresh faecal samples were collected from macaques categorised as wild, habituated and pets. Macroscopic investigation of collected faeces and McMasters technique was used to identify and quantify parasite eggs (Gillespie, 2006). Vegetation inventories, abundance and structure were recorded by conducting at least two quadrats (a 10m x 10m and 2m x 2m quadrat) at each location (Del Meidinger, 1998).

Data collected demonstrates that threats to the survival of this species are still evident. Sightings of macaques were so low that is seems the population of *Macaca nigra* has declined further since the last survey of this species; numbers of macaques also appear to be much lower outside of the protected nature reserve of Tangkoko DuaSudara.

Rationale

The study of the impact of disturbance on the wild *Macaca nigra* populations and habitats was initiated because of and to address the following issues.

1. Macaca nigra are endangered
2. Initiate conservation and increase research activities
3. Integrate *in-situ/ex-situ* efforts
4. Train future field conservationist, provide capacity building
5. Increase awareness *in-situ* and *ex-situ*
6. Establish long-term conservation and research goals

Below each of these issues are explored and the actions taken to address them outlined.

1. Macaca nigra are endangered

M. nigra are listed as Endangered (IUCN, 2006), on the basis of data collected in 1996 (Rosenbaum *et al.,* 1996a, 1996b; Eadey, 2000). Previous surveys of *M. nigra* have concentrated on population densities within a small part of their range in Minahasa, especially within the Tangkoko DuaSudara Nature Reserve. This reserve is afforded greater protection than other areas in Minahasa, so estimations from surveys here are likely to result in artificially inflated estimations of *M. nigra* populations. In addition, at the time of this current study, there were 3 habituated troops of macaques in this area which increase the likelihood and number of macaques observed. There has been a marked decline in the population densities for *M. nigra* within Tangkoko over the last 30 years; from at best 300 to at worst 23 macaques per km^2. It is likely that *M. nigra* populations have declined further since the last published surveys conducted in 1996. To fully appreciate the current status of *M. nigra* a survey needs to be carried out which is an extension of previous surveys to include more of the *M. nigra's* range in Minahasa.

- Undertake a new census using sites spread through Minahasa.

2. Initiate conservation and increase research activities

Conservation of *M. nigra* can only move forward by having an accurate idea of their current predicament. This can be established by understanding the pressures which are placing them in danger and an appreciation of how they are viewed within society. Hunting has been identified as one of the main threats to the survival of *M. nigra* (Lee, 2000).
The level of hunting pressure The number of traps observed when performing the survey in macaque habitat will also provide a useful indicator of hunting pressure; though many traps are indiscriminate in their target species and able to trap many different species. More recently the detrimental impact of human disturbance on health and thus decreased survival of threatened species has been highlighted. For example, Gillespie and Chapman (2006) found that parasitic infestation in red colobus was significantly higher areas of forest fragmentation.

Of paramount importance and consequence to the distribution and population of *M. nigra* is habitat quality. It is suggested that *M. nigra* populations are threatened by farming which encroaches into the habitat. Habitat quality was measured using vegetation parameters and an index of bird species diversity.

- Evaluate human activity, interview villagers
- Evaluate human disturbance, record trap numbers along trails
- Monitor human-animal health, parasite survey of pet, habituated and wild *M. nigra*
- Monitor habitat quality, vegetation and bird survey,

3. Integrate *in-situ/ex-situ* efforts

Although the conservation of *M. nigra* rests on the actions and activities of people within Sulawesi, integrating in-situ and ex-situ resources will undoubtedly improve our attempts to the conserve them and their habitats. Integration facilitates high quality science, the provision of appropriately experienced and skilled personnel, and aids in the creation of networks which can be used to implement recommendations which result from data collection.

There is a relatively secure population of *M. nigra* within European Zoos (N=29), which has been achieved through the management of a European captive breeding programme (EEP). At the end of 2005, 186 individuals were maintained in European Zoos (Melfi, 2006). Outside of Europe, the captive population of *M. nigra* was not quite as secure with only 74 animals being recorded in other regions; this is probably artificially low, as not all zoos subscribe to ISIS (ISIS, 2006).

Table 1: Number of captive *M. nigra* recorded on ISIS (2006).

Association	No. of zoos	No. of animals
EAZA	29	74.106.6
AZA	7	22.21.4
ARAZPA	1 (Perth)	3.3.0
Elsewhere	4	11.9.1

Male.female.unknown

Disseminating information of *in-situ* conservation activities to those working *ex-situ* will raise the profile and status of *M. nigra* in zoos, hopefully catalyzing more zoos into supporting the conservation of this species and their habitats, both *in-situ and ex-situ.* Support may take the shape of: 1) increased demand for *M. nigra* as exhibits in zoos; 2) improved conservation education; 3) financial or other support of *in-situ* conservation and research activities; 4) improved awareness of the conservation need of *M. nigra* and their habitats; 5) cross pollination of ideas and actions to promote *M. nigra*

- Create a team with *in-situ* and *ex-situ* conservation experience
- Disseminate information to interested parties *in-situ* and *ex-situ*

4. Train future field conservationist, provide capacity building

It is obvious that future conservation of species and habitats can only be achieved in the long term, where the needs of local people and their neighbouring habitats can be are harmonious. To achieve this, a long term perspective is needed which considers training local people so that they are best able to determine how and implement what is necessary to conserve their local environment. More broadly, to ensure conservation remains a high priority an appropriately trained and motivated next generation of conservationist biologists is needed; which we can contribute to through the provision of training opportunities and support. In addition, the provision of field equipment which can be used for future research and conservation will also be helpful.

- Support and supervise 3 BSc and 2 MSc students (Indonesian, French and British)
- Provide equipment for the long-term study of *M. nigra*

5. Increase awareness *in-situ* and *ex-situ*

The value of the data collected will be borne out by how widely and generally it can be disseminated. As such it is anticipated that the data collected, conclusions and suggested actions are made available to as many audiences as possible, through many different mediums and by all team members. This will hopefully motivate greater support of *M. nigra* conservation and importantly of their habitats and the region of Minahasa and Sualwesi in general.

- Audiences: local people and organisations, the science and zoo community
- Forms of dissemination: interviews, presentations, publications, t-shirts!

6. Establish long-term conservation and research goals

Information gained will be used as evidence to support the need for a future long-term conservation strategy. These data will be provided to the IUCN Asian Primate Committee for future assessment of *M. nigra* listing and as a starting point for a future strategy meeting of stakeholders (to be held in 2008).

Aims

Create an integrated long-term conservation/research strategy for this species.

1. Formalise a working partnership between interested parties *in-situ* and *ex-situ*.
2. Undertake a survey of Northern Sulawesi to estimate wild *M. nigra* population densities and distribution.
3. Maximise the impact of research undertaken on this species by combining in-situ and ex-situ data collected
4. Disseminate results, through publication in peer-review and professional journals and the European studbook; also through presentations e.g. at EAZA and International Primate Society Meeting, Edinburgh 2008.
5. Support capacity building of new conservationists/scientists.
6. Identify future conservation/ research activities, methods to achieve them and a fundraising and implementation plan.

Background

The island of Sulawesi covers 174,600 km^2, has a population of 16million people (2005) and is divided into six provinces (figure 1). The majority of people in Indonesia are Muslim (86.9%), though there are areas of high Christianity; this is true of Northern Sulawesi, where it was estimated that approximately 85% of people in Minahasa are Christian, the study site ((KSPSU 1994 cited by Lee, 2000). Sulawesi is the largest island included in the biogeographically unique region of Wallacea; totalling a land mass of 347,000 km^2. Separated from the rest of Indonesia by the Wallace's Line and from Australia-New Guinea by the Lydekkeer's Line, the flora and fauna of Wallacea have evolved to represent a high degree of endemism. As such this area has been designated as one of the 34 biodiversity hotspots, identified by Conservation International (Myers *et al*., 2000), due to the importance and uniqueness of its flora and fauna.

Figure 1: An illustration of the six provinces within Sulawesi. This study was based in the Northern Province of Sulawesi Utara (shaded green).

In addition, to the high level of endemism seen in Sulawesi, a high degree of speciation has also been observed in some species. Fooden (1969) reported 7 endemic macaque species in Sulawesi (table 1). Few researchers have studied these macaques, though there are some exceptions (e.g. Matsumura, 1998). The conservation status of the 7 Sulawesi macaques was lasted assessed by the IUCN in 2000. There are few published survey results for any of the species. Despite this 2 of the species are categorised as Endangered (*M. nigra* and *M. maura*),

Table 2: A summary of conservation status and distribution of the 7 recognised endemic macaque species found in Sulawesi.

Species *Macaca …*	Common name	Distribution	IUCN red list category	Captive populations (ISIS)
nigra	Black crested	Northeast	EN ($A1_{acd}$)	Yes
nigrescens	Gorontalo	North	LR/cd	No
hecki	Heck's	Northwest	LR/nt	No
tonkeana	Tonkean	Central	LR/nt	Yes
maura	Moor	Southwest	EN ($A1_{cd}$; B1 & 2_{cde})	Yes
ochreata	Booted	Southeast	DD	1 individual
brunnescens	Buton	Islands of Buton and Muna, SE.	VU (C1)	No

M. nigra inhabit the Northern most tip of Sulawesi, a region called Minahasa. Its provincial capital is Manado, the population of which has doubled in recent years (pers. comm. J Tasirin). Unlike much of Indonesia, and the rest of Sulawesi, Minahasa is a predominantly Christian area.

This current study has several components which will be used to address the main study question, what is the influence of human disturbance on *M. nigra* population and habitats?

***Macaca nigra* census and distribution**

Census data, of macaque sightings, will be collected by walking trails throughout the *M. nigra* home range (Minahasa). In addition, villagers near to trails will be interviewed to determine their perceptions of *M. nigra* numbers and to establish what human-animal interactions occur in that area. Human disturbance will be empirically measured in terms of the number of traps observed along trails. Additional indices measured at each site are explained below.

Previous studies have demonstrated that humans indirectly damage wild primate populations via two main routes, through: 1) the transmission of human disease and parasites, which wild primates are not adapted and can not counter an appropriate immune response, and 2) an increased risk of poor health associated with living in proximity to human or in habitats with obvious signs of human disturbance. For example, *Colobus guereza* living in logged habitats have significantly elevated parasite burdens compared to counterparts in undisturbed habitats (Chapman *et al*., 2000). Ingle-Jones and colleagues have begun to study the health parameters of Sulawesi macaques; for example studying parasite burdens in pets representing 6 of the 7 endemic macaque species (Ingle-Jones *et al*., 2004). Non-invasive assessment of *M.*

nigra health will be accomplished in this study through the estimation of parasite burden in faecal samples. The effect of human disturbance on health will be evaluated by comparing the estimated worm burdens of macaques which are free-living (wild), habituated (in Tangkoko and studied long-term by researchers and visited by tourists) and pets (caged or restrained by owners). Information gained in this part of the study will increase our understanding of the threats posed to the health of wild *M. nigra* populations and also improve our knowledge of how to manage *ex-situ* populations of this species.

Bird species diversity will be used to provide an indication of habitat quality. Previous studies have found that forest degradation, e.g. fragmentation, results in a decrease in species diversity (Turner 1996). In addition, bird species seen associating with *M. nigra* will also be recorded. Previous studies have suggested that certain bird species associate with primates (e.g. Boinski and Scott 1988). There is much anecdotal evidence that four bird species associate with *M. nigra:* yellow-billed malkohas *Phaenicophaeus calyorhynchus*, drongo *Dicrurus hotentotus* and cuckoo *Centropus celebensis*. There is some evidence that indeed yellow-billed malkohas associate with another Sulawesi macaque, the moor macaque e.g. Matsumara (2001).

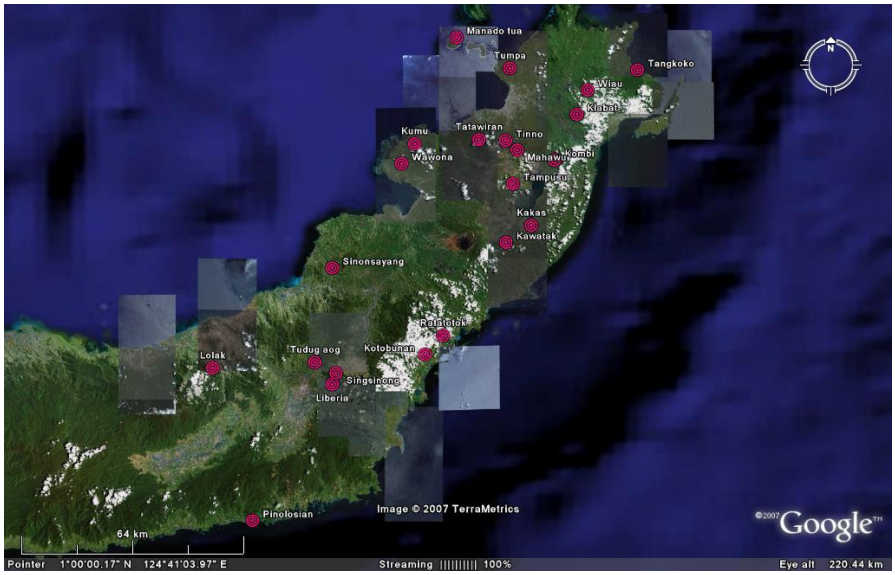
Finally information about habitat quality will be evaluated through vegetation surveys. As generalists, Sulawesi macaques have been observed in all six described habitat types in Northern Sulawesi, which includes coastline, mangrove, rainforest and volcanic elevations (O'Brien and Kinnaird, 1996). A botanical inventory and its subsequent abundance will be recorded at all sites visited. This will provide an indication of habitat quality and will also be used to determine whether there are any vegetation indices which are associated with the presence of *M. nigra*.

Data collection

Study sites

Study sites have been selected which are evenly distributed over the whole range of the *M. nigra*'s range (Figure 2). The southerly sites (Pinolosian and Lolak) represent areas where *M. nigra* and *M. nigrescen* ranges may overlap. Mountains are the predominant features in Minahasa, and also the location for many of the study sites; though a couple of trails follow low lying land (e.g. the trail named, Tangkoko WCS C) or start at sea level before climbing to higher elevations.

Figure 2: An illustration of the study sites distributed across Minahasa.



Some sites had been previously surveyed (Lee *et al.*, 2001; Sugardijtio *et al.*, 1989; table 3), while others were new. Where possible current trails attempted to follow paths taken in previously surveys; this was possible for Tangkoko, Ambang and Manembo-nembo). However for the majority of transects which were new, interviews (see method below) were undertaken in the nearest village to the designated trail location and a local guide (usually a hunter) used to find or follow trails into the forest to locations where macaques have been reported. These trails were highly variable, in terms of their length, vegetation quality, extent of farming and other human disturbance parameters (though traps have been found in all of them). The routes were largely determined by topography, ease of access and conditions on the day of data collection; GPS coordinates have been recorded along all transects.

The length of trails are detailed in table 3 and descriptions are provided in Appendix B. Those not walked were either inaccessible or represented areas with >85% farmland and thus not considered potential *M. nigra* habitat (table 3). To ensure comparability with previous surveys, methods of data

Table 3: A summary of trails followed in previous surveys and those trails proposed and followed in the current survey. The number of sightings and consequent estimation of *Macaca nigra* population in these areas.

Area	Location	Transect (T: # & total length) & SCBM obs (SCBM: # & popn est.)				
		Proposed		Previous		Current
		#	days	WCS '99-2000	Sugardito '89	Melfi '07
Northern tip	Tangkoko Duasudara	15	5	T: 5x @ 5km (99.5km)*; SCBM: # 21 (++)	T: 124.5km; SCBM: (+++/++)	T: 4 x 3.9km (total 15.3km); SCBM: # 6 (++)
Northern tip	Mt. Wiau	2	1			T: 3x 1.5km (total, 4.5km); SCBM: (ø)
Northern tip	Mt. Klabat	2	1		T: 19.5km; SCBM: (ø)	T: 3x 2.6km (total, 7.8km); SCBM: (ø)
Northern tip	Likupang-Wori	2	1			☒
Northern tip	Mt. Tumpa	2	1			T: 3x 1.1km (total, 3.3km); SCBM: (ø)
Tatawiran complex	Mahawu	2	1			T: 3x 1.3km (total, 3.9km); SCBM: (ø)
Tatawiran complex	Lokon (Tinno instead)	2	1			T: 1x 1km; SCBM: (ø)
Tatawiran complex	Tatawiran	2	1			T: 1x 4.32km; SCBM: (ø)
Tatawiran complex	Manembo-nembo	5	5	T: 2x 1.8km (10.8km); SCBM: # 3 (++)	T: 6.5km; SCBM: (++)	
	(Senduk)					☒
	(Wawona)	1				T: 1x 10.7km; SCBM: (ø)
	(Kumu)					**T: 3x 1.9km (total, 5.7km); SCBM: #1 (+)**
Lembean Range	Minawerot	1	1			☒
Lembean Range	Kombi	1	1			T: 1x 2.2km; SCBM: (ø)
Lembean Range	Eris	1	1			☒
Lembean Range	Kakas	1	1			T: 3x 2.8km (total 8.4km); SCBM: (ø)
Inland Minahasa	Mt. Tampusu	1	1			T: 3x 1.3km; (total 3.9km); SCBM: (ø)
Inland Minahasa	Mt. Kawatak	2	1			T: 3x 2.2km (total 6.6km); SCBM: (ø)
Inland Minahasa	Mt. Manimporok	1	1			⊗
Inland Minahasa	Mt. Kalilondey	1	1			☒
Inland Minahasa	Mt. Rindengan	1	1			☒
Motoling Landscape	Liandok	2	2			⊗
*Motoling Landscape	Eluson				T: 20km; SCBM: (ø/+) (Eluson/ Pondus)	☒
Motoling Landscape	Motoling[T]	2	1			☒
Motoling Landscape	Mt. Lolombulan[T]	2	2			⊗

Area	Location	Transect (T: # & total length) & SCBM obs (SCBM: # & popn est.)				
		Proposed		Previous		Current
		#	days	WCS '99-2000	Sugardito '89	Melfi '07
Ambang Range	Mt. Ambang (Sinsingon)	5	5	T: 4x @5km (63.15km)*; SCBM: # 5 (+)	T: 22.5km; SCBM: (ø)	T: 5x 2.1km (total 14.52km); SCBM: (ø)
Ambang Range	Mt. Sinonsayang	2	2			T: 1x 6.6km; SCBM: (ø)
Ambang Range	**Mt. Ambang (Liberia)**					**T: 3x 2.2km (total 6.6km); SCBM: # 1 (+)**
Ambang Range	**Mt. Bumbungan/ *TDA**	**2**	**3**		**SCBM: (ø)**	**T: 1x 4.1km; SCBM: # 1 (+)**
Pasaan Landscape	Belang	2	2			☒
Pasaan Landscape	Ratatotok	2	2			T: 2x 1.2km (total 2.4km); SCBM: (ø)
Pasaan Landscape	Kotabunan	2	2			T: 2x 6km (total 12km); SCBM: (ø)
Crossing S borders	**Pinolosian**	**2**	**3**		**SCBM: (ø)**	**T: 2x 5.9km (total 11.8km); SCBM: # 1 (+)**
Crossing S borders	Lolak	2	3			T: 3x 3km (total 9km); SCBM: (ø)
Islands	Manado tua					T: 1x 5.5km; SCBM: (ø)
Total		69	53	11 (3 locations) (total 173.5km)	7 locations (total 193.5km)	52 (22 locations) (total 150.14 km)

Transect locations:
RED: to close to other sites
GREEN: farmland ~ so not visited
BLUE: new area
GREY: not accessible, bad roads or military area
BOLD: animals found

SCBM observations:
Ø no sightings
Number of animals estimated:
+++, > 50/km^2; ++, 10-40/km^2; + <10/km^2;

collection followed those used by Rosenbaum *et al*. (1998). Trails were walked quietly, with stops every 100m to visually scan and listen for sounds. All trails began at 0600 and, depending on the terrain, continued until about 1200. All sightings of *Macaca nigra* were recorded including, were possible, number of individuals, horizontal distance from the observer to the first animal seen and the location along the trail (using GPS coordinates). Signs of human disturbance were noted along trails and the number of traps observed categorised for analysis (0, >10, 15-45, >50).

Interviews
People living in settlements close to the beginning of proposed trails, or encountered while walking the trails, were surveyed (table 4). A similar method conducted by Pombo *et al*. was adopted (unpublished, appendix A).

Table 4: The number of people interviewed either in villages, if close to the trail location, or whilst on walking the trail.

Village (Mountain)	No of people surveyed
Lolak	10
Kombot (Pinolosian)	7
Tudug aog (Ambang)	6
Liberia (Ambang)	7
Sinsingong	6
Tondey	3
Paslaten	6
Wawona (Manembo-nembo)	6
Kumu (Manembo-nembo)	7
Mahawu	8
Tindoor	1
Molas	9
Pinilih	11
Airamadidi (Klabat)	10
Kawatak	9
Pangolombian	7
Agotey	9
Batuputih (Tangkoko)	8
Kasuari (Batuangus)	5

M. nigra faecal sampling

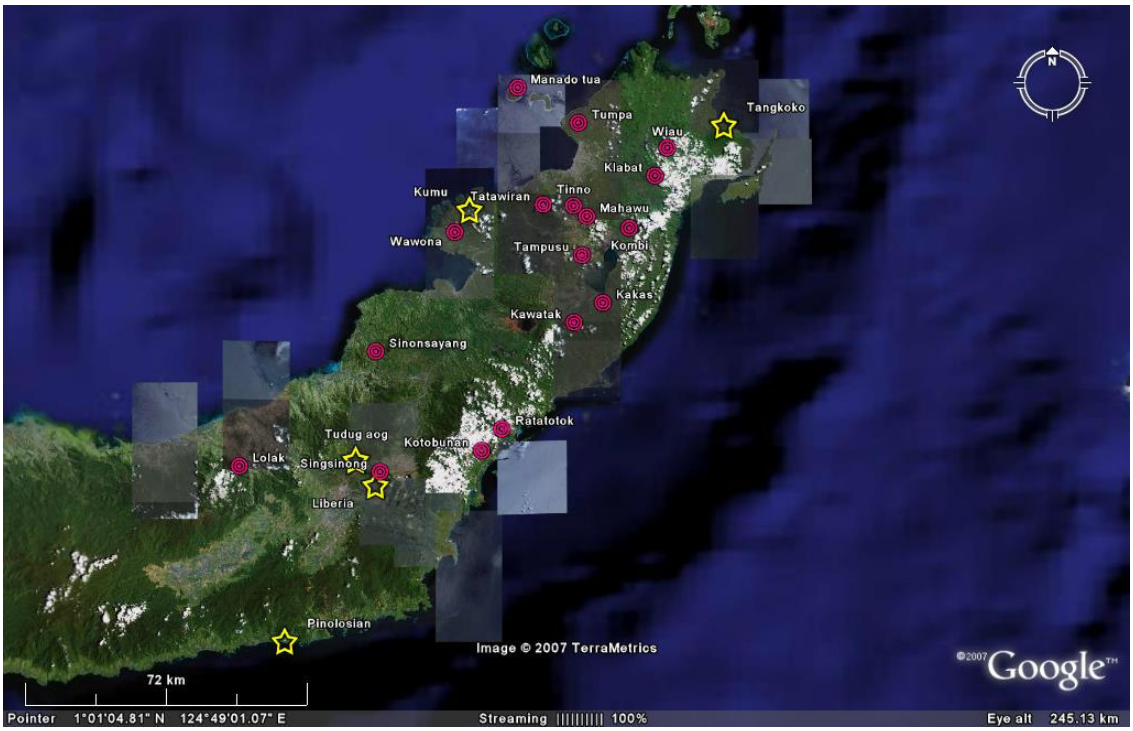
Fresh faecal samples were collected along trails and from 'pet' macaques, found within Minahasa. Samples were collected in plastic bags and stored until laboratory examination. Due to the robust nature of trematode and nematode eggs, it was considered that this crude method of storage would not compromise their identification and quantification which was achieved using the McMasters technique identify and quantify parasite eggs (Gillespie, 2004). Fifty-five samples were collected from wild macaques (N=22) i.e. from along trails; habituated (N=20) i.e. from Rambo dua at Tangkoko; and from pet (13) macaques. The sex (males = 10; females = 8; unknowns = 23) and estimated age (ranging from < 1 – 10 years) of these macaques are listed in Table 5.

Macaca nigra census and distribution

In total 52 trails were walked in 22 locations, totalling 150km. Trail length was calculated as the distance taken to walk one way along a route, i.e. if the trail was circular and so the route was not repeated the entire distance was used. However, if the trail was repeated (i.e. walked on the way there and then again on the way back) the trail distance estimation was taken for only ½ the trail.

Only 9 macaque sightings were made whilst following these trails. Five sightings occurred at Tangkoko and represented habituated (#50 individuals), semi-habituated (x3; total #36 individuals) and a wild troop (#7 individuals). Two sightings occurred the Ambang mountain range (Tuduaug, #3 individuals; Liberia, #1 individual) and the two other sightings occurred within the Manembo-nembo nature reserve (#3 individuals) and Pinolosian (#5 individuals). All of these locations are considered protected; though human disturbance was obvious in all areas. The location of the sightings are illustrated in Figure 3.

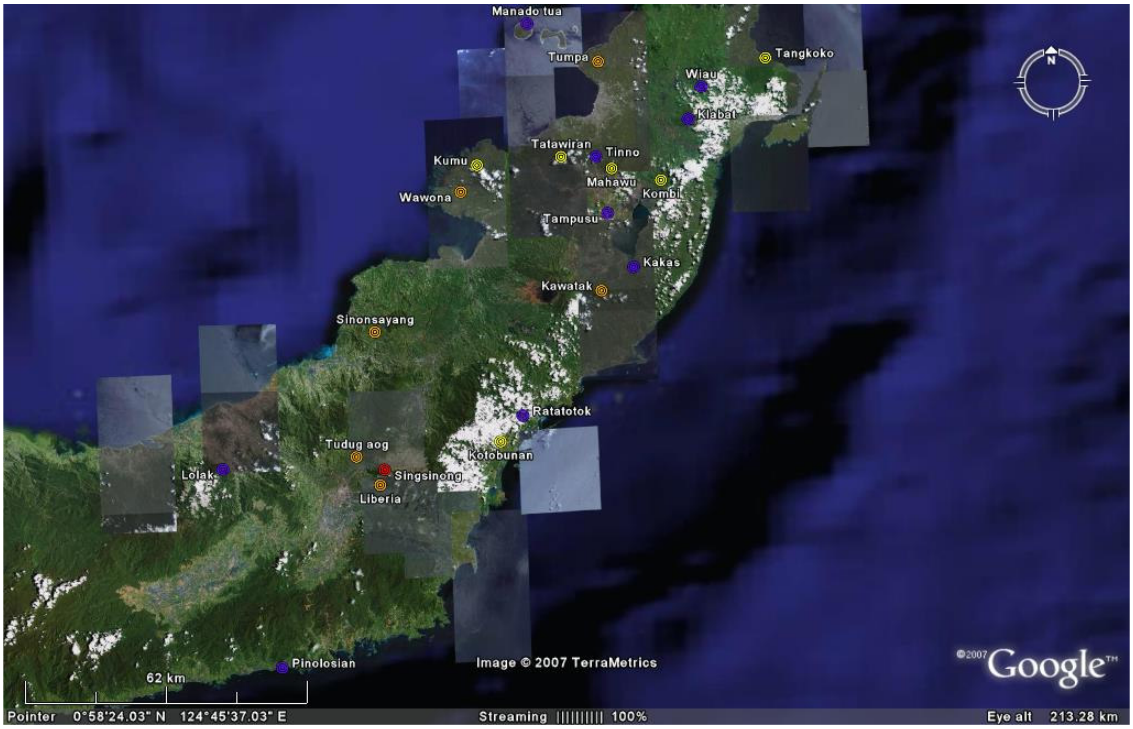
Figure 3: Macaque sightings occurred in 5 (yellow star) out of 22 (red circle) sites surveyed.



Human disturbance

All trails were affected by human disturbance. A variety of traps were observed from simple and specific rat traps (figure 4), to more generalist traps (which could catch a variety of species) and also mist nests (for catching bats). The distribution of traps was widespread and their abundance was not diminished in protected areas. For example over 50 traps were observed along a trail in Singsinong, which is part of the protected Ambang nature reserve; it also has a ranger station in the nearby village (about 5km away). Figure illustrates the number and distribution of traps found.

Figure 4: An illustration of the number of traps observed along trails (blue = 0; yellow <10; orange = 14-45; red >50).



Villagers' perceptions

Many of the villagers surveyed, visited the forest frequently (figure 5). Some villagers lived in the forest, and many others visited the forest daily. The main reason for going into the forest was to farm (figure 6). Hunting was recorded to occur in about ½ the sites surveyed and providing guided tours of the forest occurred at 2 sites. There was high degree of variability in the villagers' responses to 'when was the last time you saw macaques' (figure 7). Of those villagers that had seen macaques, they reported seeing small groups (of the <50 macaques; figure 8). Figure 9 and 10 provide an illustration of the diverse array of foods which the macaques have been seen to eat and the other animals observed in the forest.

Figure 11 confirms that the majority of macaques which were observed were indeed *M. nigra* and that in the majority of villages they actively hunted them.

Figure 5

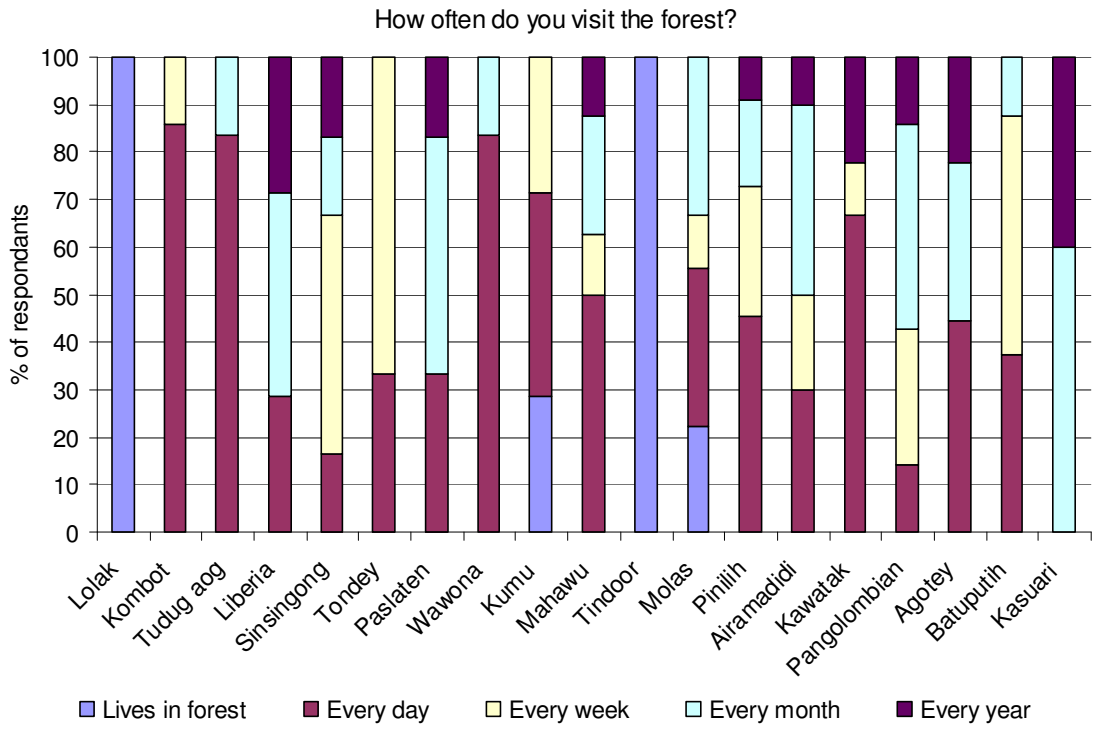


Figure 6

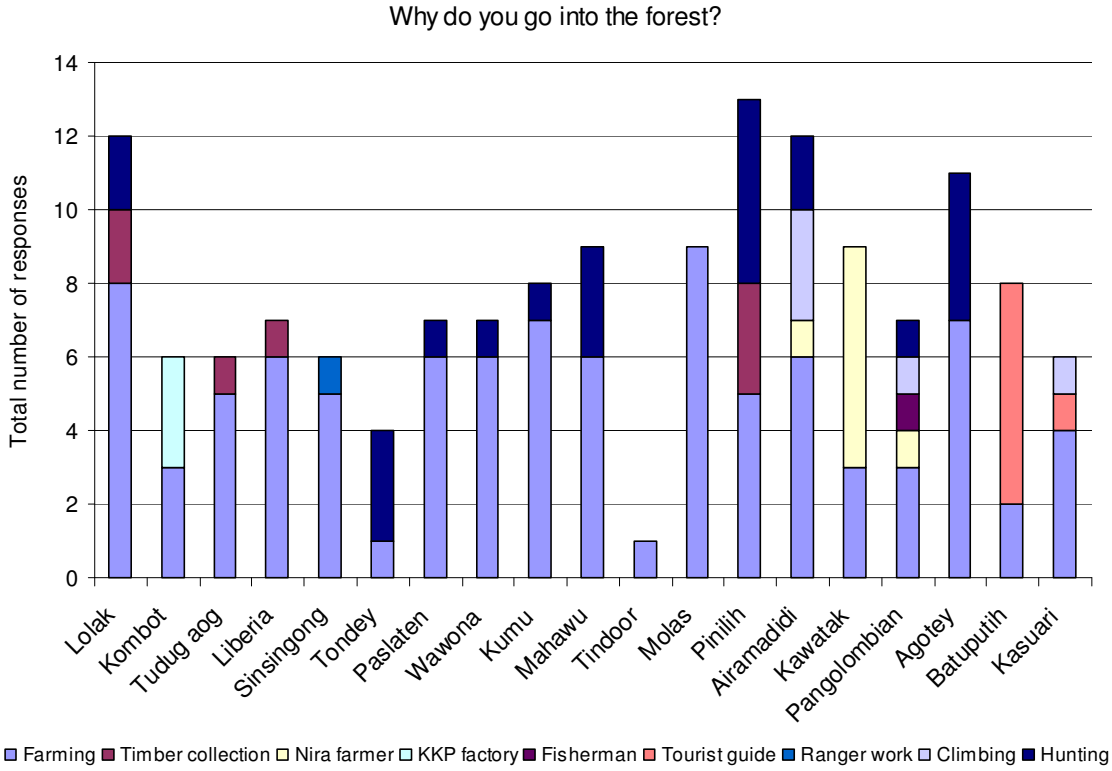


Figure 7

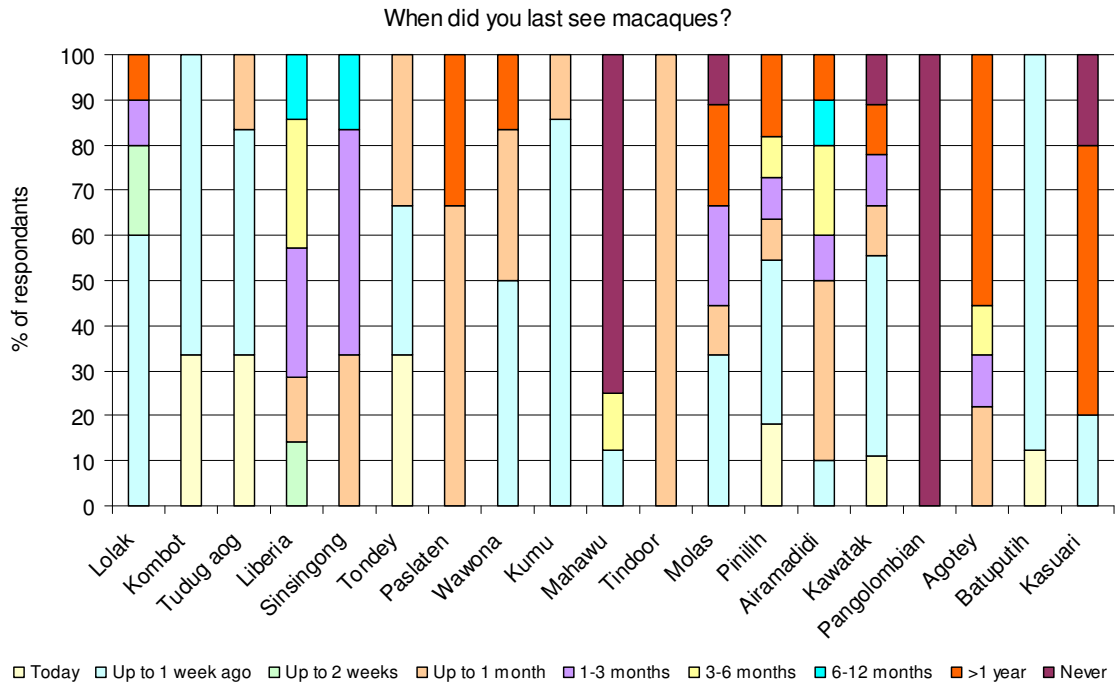


Figure 8

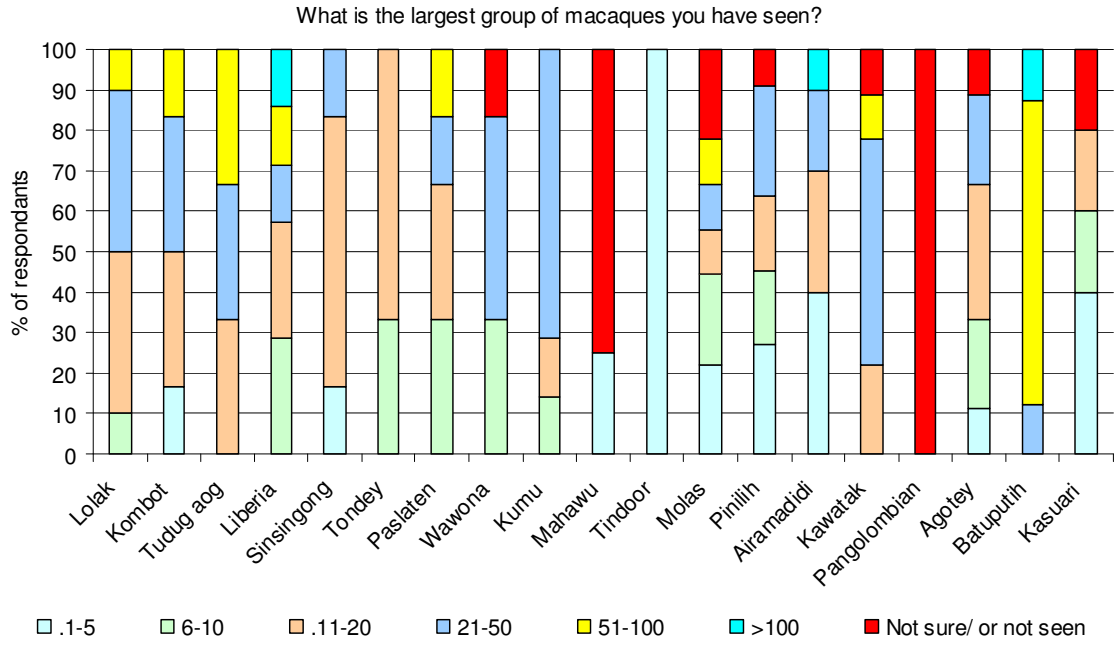


Figure 9

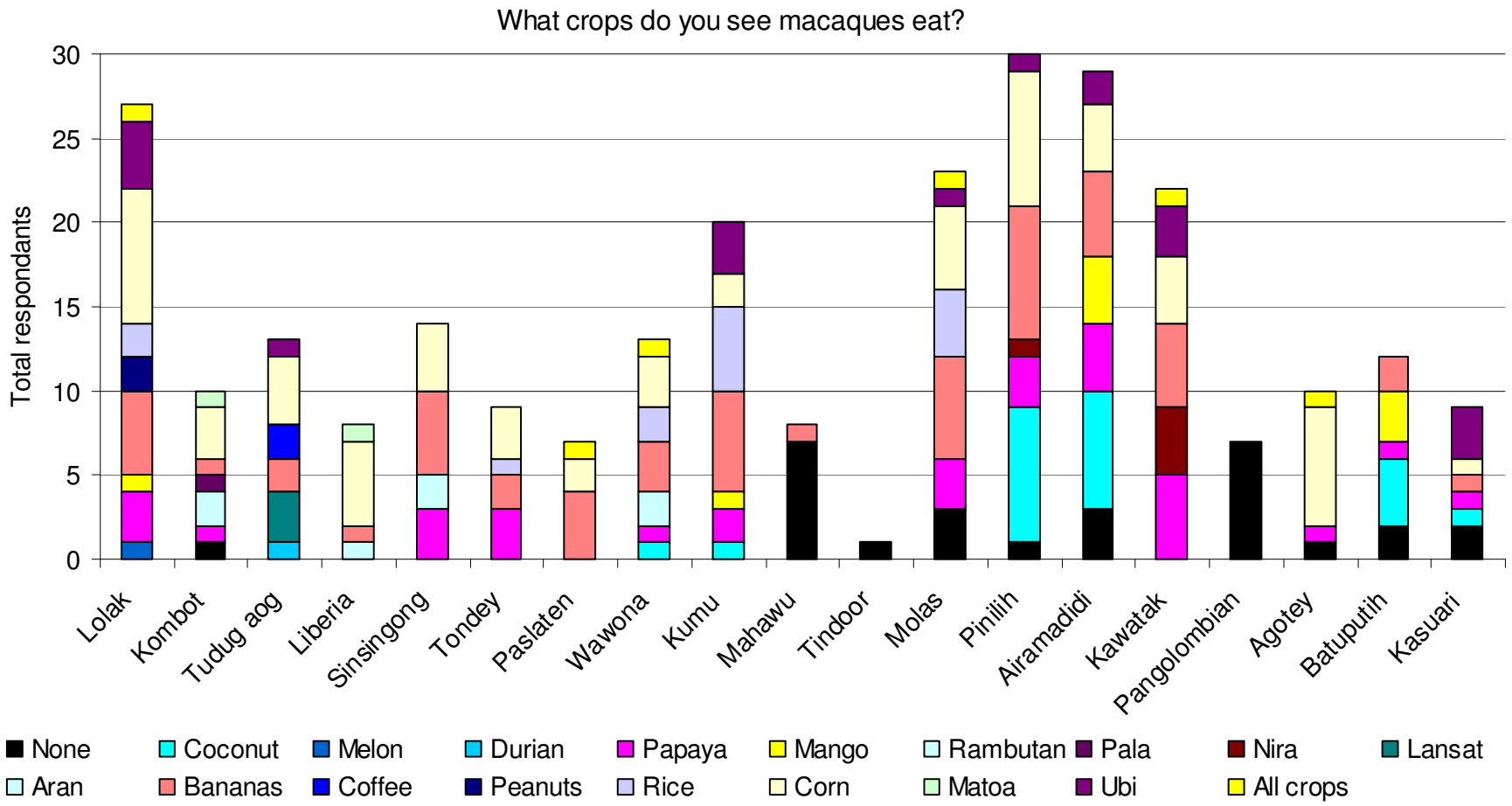

What crops do you see macaques eat?
Total respondants
30
25
20
15
10
5
0
Lolak
Kombot
Tudug aog
Liberia
Sinsingong
Tondey
Paslaten
Wawona
Kumu
Mahawu
Tindoor
Molas
Pinilih
Airamadidi
Kawatak
Pangolombian
Agotey
Batuputih
Kasuari
None
Coconut
Melon
Durian
Papaya
Mango
Rambutan
Pala
Nira
Lansat
Aran
Bananas
Coffee
Peanuts
Rice
Corn
Matoa
Ubi
All crops

Figure 10

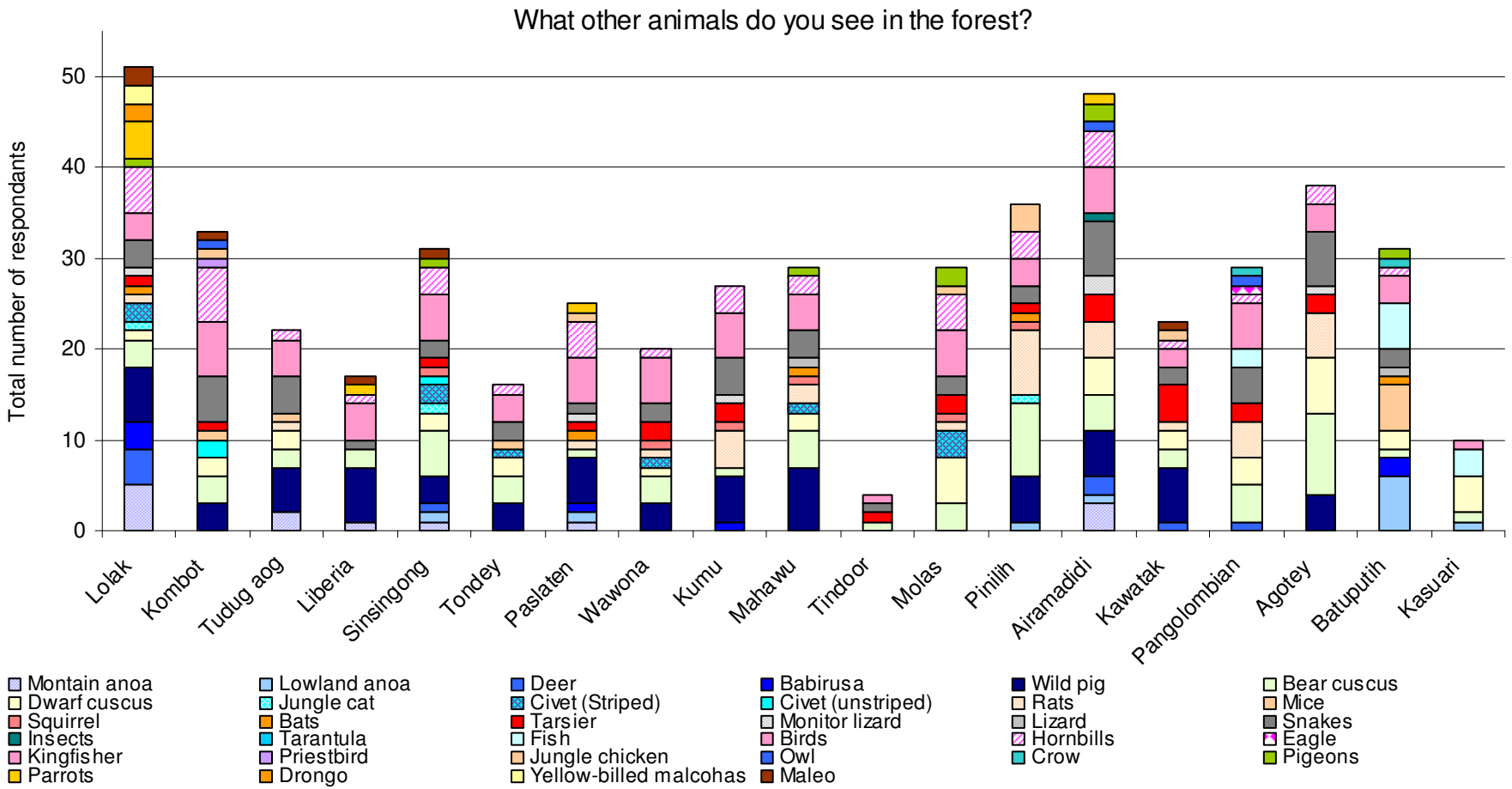

What other animals do you see in the forest?
Total number of respondants
0
10
20
30
40
50
Lolak
Kombot
Tudug aog
Liberia
Sinsingong
Tondey
Paslaten
Wawona
Kumu
Mahawu
Tindoor
Molas
Pinilih
Airamadidi
Kawatak
Pangolombian
Agotey
Batuputih
Kasuari
Montain anoa
Lowland anoa
Deer
Babirusa
Wild pig
Bear cuscus
Dwarf cuscus
Jungle cat
Civet (Striped)
Civet (unstriped)
Rats
Mice
Squirrel
Bats
Tarsier
Monitor lizard
Lizard
Snakes
Insects
Tarantula
Fish
Birds
Hornbills
Eagle
Kingfisher
Priestbird
Jungle chicken
Owl
Crow
Pigeons
Parrots
Drongo
Yellow-billed malcohas
Maleo

Figure 11

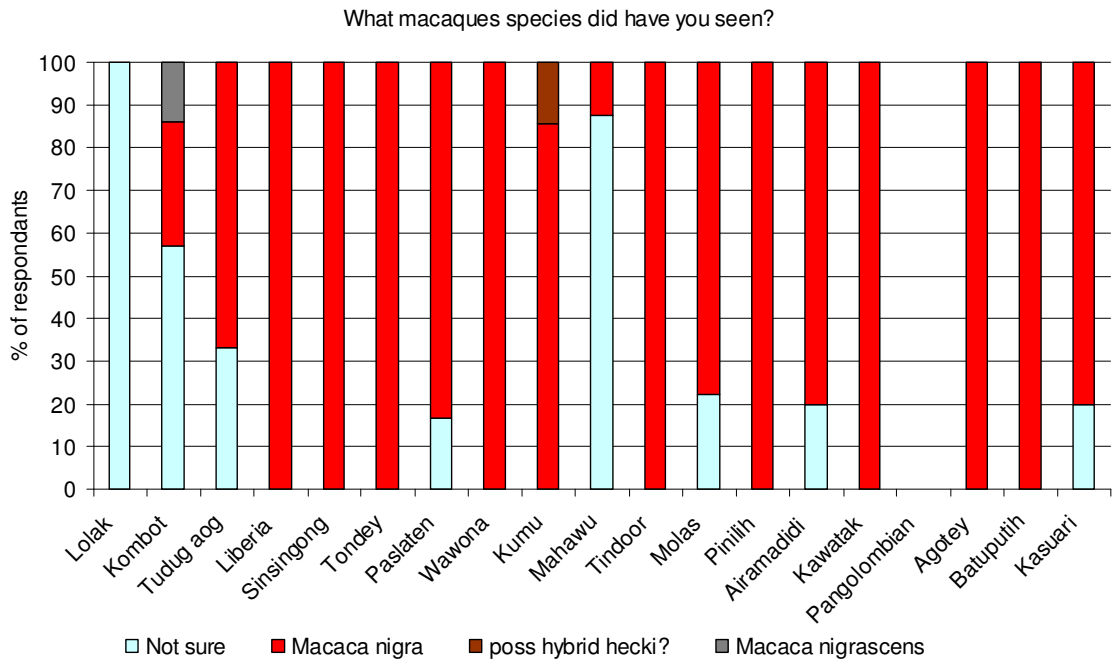
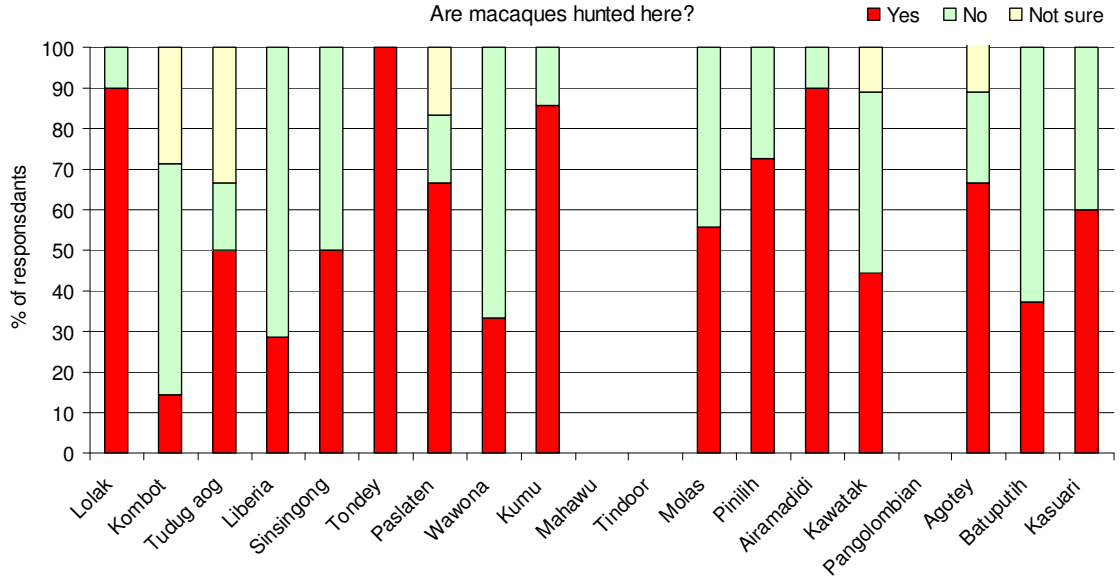


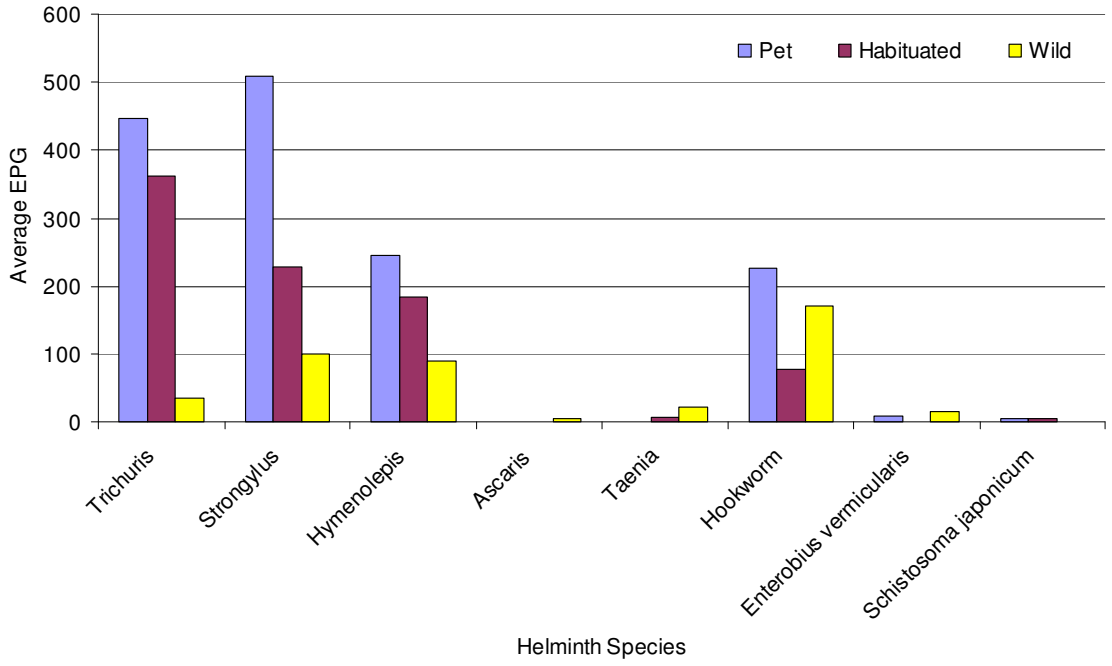
Figure 12



Parasitology

In summary, as expected to total number of eggs declined with human contact: pets (total, 15850, average, 1441); habituated (total 17350, average 867.5); wild (total 8750, average 437.5).

Figure 13: Comparison of average eggs per gram faeces (epg) for each helminth species observed in each category of macaque (pet, habituated and wild).



Conclusions

According to previous estimates of *M. nigra* populations, we should have expected to encounter a minimum of 23 animals per km^2 walked along trails. Encounter rates only reached this level in one location, the protected Tangkoko DuaSudara Nature Reserve (though sightings were lower in the current survey compared to previous surveys). In most locations no macaques were encountered at all. From these data we would suggest that macaque populations are higher in the small protected site of Tangkoko relative to the rest of their home range. As such population estimates for this species based on survey results carried out in Tangkoko (estimated to be around 106,000) are considerably higher than the actual population.

Future work to conserve this species will be targeted at reducing the threats to their survival, rather than undertaking more surveys. As population surveys require high investment in terms of finances and time. Despite the current data representing three months work and including many more sites than previous surveys (thus better representing the macaques home range) trails were only walked once, thus the repeatability of the data were not tested.

We are optimistic that the data collected in this study will provide evidence enough that a long-term conservation strategy is necessary to prevent the extinction of this species, and potentially that of the other macaque species on Sulawesi. These data demonstrate that there is a continued decline in the *M. nigra* population.

Outcomes

Data are yet to be analysed and so no conclusions are currently available. However, the following has been accomplished to date:

a. Formalised collaborations with:
   Dr John Tasirin and Dr Martina Lange (Sam Ratulangi University, WCS, Sulawesi programme)
   Dr Antje Engelhardt (German Primate Research Centre).
b. Team successfully collected data
   Formed the basis of their BSc and MSc degree dissertations
   Has confirmed that threats to the future survival of *M. nigra* are still present
c. Publications and presentations listed below
d. A meeting has been arranged to discuss and outline a long-term conservation strategy for *M. nigra*, with the local stakeholders.

Publications:
A Jonas and VA Melfi (submitted to Animal Welfare) *M. nigra* parasitology.
VA Melfi (February 2008) Report to ZSL for expedition grant.
VA Melfi (July 2007) Draft preliminary report ~ LIPI, ZSL, PZEP.
B Sabintoe (July 2007) Bird association with *M. nigra*. Bachelor scripts. UNSRAT, Forestry dept.).
R Kambe (July 2007) Vegetation survey of *M. nigra* habitats. Bachelor scripts. UNSRAT, Forestry dept.).
A Yosep (July 2007) Population densities and distribution of *M. nigra* habitats. Bachelor scripts. UNSRAT, Forestry dept.).
A Jonas (August 2007) *M. nigra* parasitology. Masters thesis University of Plymouth.
F Houssaye (August 2007) Vegetation survey. Masters thesis, University of Plymouth.
VA Melfi (August 2007) Summary report of findings. 8th EAZA Sulawesi macaque EEP studbook.

Articles have been drafted for distribution to BIAZA; EAZA; AZA; ARAZPA; SEAZA. Peer-reviewed papers, including: comparisons of census data between 1996 and 2007; what environmental factors predict the presence of *Macaca nigra;* a comparison of wild and captive *Macaca nigra* sexual swellings and parasite burdens; how has disturbance shaped North Sulawesi in the last 10 years.

Presentations (to date and planned):
VA Melfi (August 2007) Bristol Zoo Science Colloquium, Bristol Zoo.
VA Melfi, N Jago (August 2007) Zoo Information Talk, PZEP
VA Melfi (September 2007) EAZA AGM, Warsaw.
VA Melfi (November 2007) Torbay Lions Club, Paignton.
VA Melfi (November 2007) ZSL, Expedition grants conference
A Jonas (December 2007) UFAW, Vacation Scholars conference, Moultan College.
VA Melfi, N Jago (February 2008) Evening lecture, PZEP
VA Melfi (August 2008) Congress of the International Society of Primatology, Edinburgh.

Appendix A: Interview questions

Questions asked during interviews:

1. How often do you visit the forest?
   2x week; 1x week; 2x month; 1 every 2 months

2. Why do you go into the forest?
   Hunting; collecting fire wood etc.

3. When was the last time you saw SCBM?

4. What size is the largest group of SCBM you've seen?
   5-10; 11-25; 26-50; 51-75; 76-100; 101-125 etc.

5. Which crops do SCBM eat?

6. Which other animals do you see in the forest?

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